Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

The Editors Note.

EVIDENCE of Mexico's continued and growing interest in astronomy comes with the welcome news that a Mexican expedition will travel to Peru to observe the total eclipse of the sun on January 25, 1944. This means that at least one expedition from North America will supplement those of South American professional and amateur astronomers to view this important celestial event.

Members of the staffs of the Tacubaya and Tonanzintla observatories will take with them two long-focus cameras, one of 19 meters, the other of eight meters focal length, and both of 11 centimeters aperture. In addition, they will use the Harvard BM camera, which is a Ross-Fecker with a 3-inch lens of 21 inches focal length; an equatorial telescope of 15 centimeters aperture; two coelostats; a chronometer, and auxiliary equipment for use with these instruments.

The Mexican expedition will include Director Joaquin Gallo, of Tacubaya, and Director Enrique Erro, of Tonanzintla. Also, there will be Dr. Carlos Graef, assistant director of Tonanzintla, Sr. Jose Alva, of Tonanzintla, and Sr. Aragon Leiva, a science writer who is now the Mexican agent of Science Service. A newsreel cameraman will accompany them.

Meanwhile, in a letter dated October 22nd, Dr. Bernhard H. Dawson, of La Plata Observatory, writes that he knows of no expeditions planned for the observation of the coming eclipse. However, he states that there may be expeditions which he has not heard of from other observatories in South America.

Charts of this eclipse were published in the October issue of **Sky and Telescope** as part of an article by Dr. Charles H. Smiley, of Ladd Observatory. We shall be very glad to receive reports and photographs from both amateurs and professionals who are fortunate enough to be in or near the path of totality, with a view to publishing as complete an account as possible of observations and results.

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FRONT COVER: The Cincinnati Observatory, which celebrates its centennial this year. At the left is the main building, built in 1873, and housing the 16-inch refractor, which was installed in 1904. In front of the main building is the latitude variation building, which dates this picture as probably between 1913 and 1920. At the right is the Mitchel building, housing the original 12-inch refractor.

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Stars for December 21

BACK COVER: The southern part of the moon around Tycho and Clavius, photographed on October 26, 1937, by J. H. Moore and J. F. Chappell, using the visual focus of the 36-inch refractor at Lick Observatory. This is a reduction of part of Plate 12 of the Lick Observatory atlas of celestial photographs. The age of the moon was 22.06 days; the exposure 0.75 second, at full aperture. A wedge-shaped focal-plane shutter increases the exposure logarithmically from the limb to the terminator, thereby compensating for the decrease in the intensity of the illumination. Tycho is the large crater 2½ inches from the right side and 5½ inches from the top of the picture. (See "In Focus.")

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ONE HUNDRED YEARS AT THE CINCINNATI OBSERVATORY

By Everett I. Yowell, *Cincinnati Observatory*

A CENTURY ago, Cincinnati was the most prosperous city west of the Alleghenies and was growing rapidly. Among her institutions of learning were three that are now parts of our University of Cincinnati — the College of Law, the College of Medicine, and the Cincinnati College, devoted to the arts and sciences. At the latter college, Ormsby MacKnight Mitchel was professor of mathematics, engineering and mechanics — a West Point graduate in the celebrated class of 1829, he became tired of routine garrison life, resigned, and came to Cincinnati. He studied law, but did not make a successful lawyer and then joined the faculty of the Cincinnati College. He became interested in astronomy and in the spring of 1842 gave several lectures on the subject. These were so well received that at the last lecture he announced a project for building and equipping an observatory. He stated he would call on various people and solicit memberships at $25 per share; when 300 members were secured they would organize a society. This meeting was held in May; the constitution was adopted and officers elected: Judge Burnet was made president, and Mitchel, the astronomer. Mitchel was sent to Europe to find a telescope. He looked in vain for a suitable one in London and Paris, and went on to Munich before he found what he wanted. It was a 12-inch glass, companion to the one used by Lamont, and inferior in size to the Poulkovo glass alone.

It cost more money than the society had; but he gave a provisional order, went back to Cincinnati, and raised the rest. Judge Longworth donated a tract of ground on Mt. Adams, on condition that the building should be finished in two years. Again Mitchel went among the people to solicit memberships. Some paid in cash, some in labor and materials, some in produce. Mitchel began the erection of the building with one carpenter and one mason as foremen and steadily added to his force. The lofty hill made hauling from the city very expensive, so Mitchel quarried limestone from the hills, constructed a kiln in which to burn lime, opened a sand pit, and even dammed a gully for water during a heavy rain. And the building was finished on time.

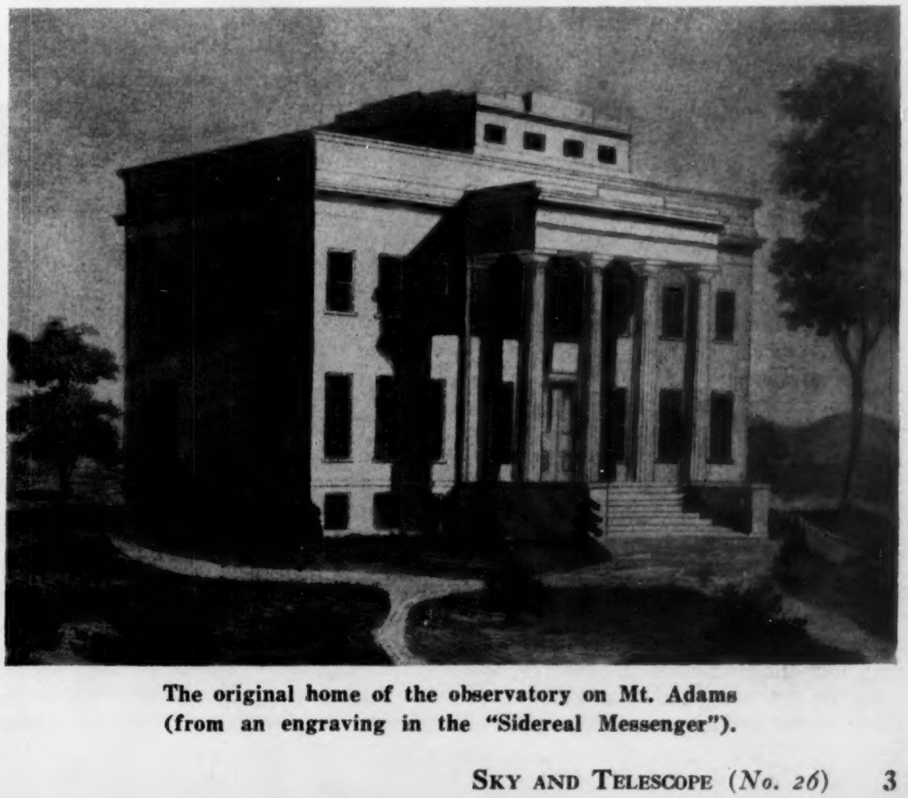
Ex-president John Quincy Adams was invited to lay the cornerstone, and in spite of his 77 years accepted. To Mitchel he wrote: "I propose to leave my home on the 25th of this month, allowing myself 13 days to arrive at Cincinnati by the way of Buffalo, Ashtabula and Cleveland. If some unforeseen accident should detain me beyond the 6th, you will ascribe it to any cause other than my will. If a spark of your enthusiasm for the cause of Science, and the honor of our Country, burns in my bosom, it shall live until the cornerstone of your observatory shall have been laid, nor shall it be delayed an hour by any neglect, indolence, or indifference of mine."

His long trip from Massachusetts was by rail to Buffalo, by boat to Cleveland, by canal to Columbus, and stage coach to Cincinnati. The latter part of the journey was an ovation, the people turning out en masse to greet him at all the small towns and cities. The city fathers met him at the city limits and escorted him to his hotel. The city declared a holiday in his honor on the 9th of November, when the cornerstone was laid; a civic and military parade escorted the honored ex-president from his hotel, through the streets and up the winding road to the summit of the hill. The heavens rained torrents, but did not dampen the enthusiasm of his audience!

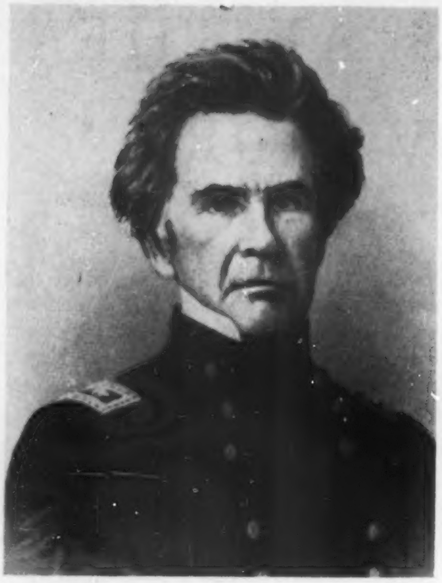
During his term of office as president, John Quincy Adams had recommended to Congress the founding of a national observatory. He had called an observatory a "light house of the sky" and this phrase had been used by his opponents in ridiculing him. He used it again in his address on laying the cornerstone. "Does your love of the arts and sciences of civilization, prompt the enquiry, whether, among these monuments of civilized industry, perseverance, ingenuity, there is one light house of the skies — one tower erected on the bosom of the earth, to enable the keen-eyed observer of the heavenly vault, and the profound calculator of the infinite series, to watch, from night to night, through the circling year, the movements of the starry heavens, and their unnumbered worlds; and report to you, and to all the civilized race of man, the discoveries yet to be revealed to the tireless and penetrating eye of human curiosity? Look around you, fellow citizens — look from the St. John to the Sabine — look from the Neversink to the mouth of the Columbia, and you will find, not one! not one!"

Despite this auspicious laying of the cornerstone, difficulties still beset Mitchel: funds had to be raised to complete the building and the last payments made on the telescope. In January, 1845, the telescope arrived in Cincinnati after the long journey via Bremen and New Orleans, and by spring it was mounted.

The observatory had no endowment, no funds with which to pay an astron-



The original home of the observatory on Mt. Adams (from an engraving in the "Sidereal Messenger").



Ormsby MacKnight Mitchel in uniform.

omer, so Mitchel agreed to act as director for 10 years without remuneration. Since the stockholders had the privilege of visiting the observatory either in the afternoon or evening, and the director was expected to entertain them and let them look through the telescope, Mitchel found his observing time limited and he had very little chance to do astronomical work, for he had to perform his duties at the college to earn his living. The society soon was forced to limit visitors to three nights per week. The college had burned down and Mitchel had to seek his livelihood elsewhere. So well received were his lectures in Cincinnati that he planned a tour in the East, where he met with amazing success and lectured to filled halls. Undoubtedly the interest he aroused in astronomy was one of the causes leading to the founding of new observatories.

Another enterprise was the publication of a popular astronomical journal, the *Sidereal Messenger,* in 1846; it was well received, but could not find enough subscribers to justify its existence. It failed in helping to support the observatory and expired in 1848. Perhaps it made the way easier for the *Astronomical Journal,* which was published a year later by B. A. Gould, and after many vicissitudes still survives and is now controlled by our American Astronomical Society.

The problem of using electrical current to record observations was in the minds of many astronomers; it is to Mitchel's credit that he found one solution by means of his disk chronograph even though the chronograph devised by the Bonds proved more satisfactory. This American way of observing was soon adopted in Europe.

Mitchel devoted his observing to southern double stars, comets, and planets; but his astronomical observations were comparatively few on account of other necessary duties. In 1860, Mitchel accepted an appointment at the new Dudley Observatory in Albany, N. Y., but on the breaking out of the Civil War, he promptly returned to the Army, conducted a successful campaign in Tennessee and northern Alabama, was transferred to South Carolina where he died, a victim of yellow fever.

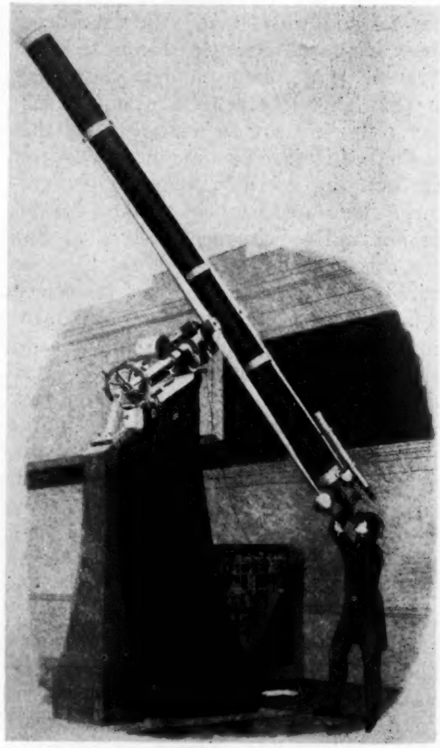
Due to the war, a period of inactivity at the Cincinnati Observatory followed — even as every observatory has been affected by the present conflict. Twitchell, the assistant, stayed for a year and then entered optical work; Davis was permitted to use the telescope and to dwell in the building on condition that he kept the place in repair.

In 1867 steps were taken to revive the society: a meeting of the stockholders was called and new officers and board of control were elected. Most prominent among these new officers was Alfonso Taft, the president, who later became Grant's secretary of war, and whose son Howard became president of these United States. A plan was formed to support the observatory for three years by soliciting subscriptions of $100 per year from prominent citizens. When this support was assured, Cleveland Abbé, a young astronomer fresh from two years' work under Struve at Poulkovo, was elected director. He came to Cincinnati and assumed his office in June, 1868. In his first report, Abbé says: "A system of storm predictions having proved itself in Europe and India as of the very greatest usefulness and value, an attempt is now being made to bring about such a system here." The successful completion of this project was to be the feature of Abbé's work at Cincinnati.

Already the newspapers were publishing some meteorological data. Our Cincinnati Chamber of Commerce agreed to finance the project for three months; the Western Union Telegraph was to transmit the data and Prof. Abbé was to analyze it and issue the weather report. Prof. Abbé secured the cooperation of observers in various parts of the country and issued his first bulletin on September 1, 1869. Abbé used the word "probably" so much in his predictions that he was nicknamed "Old Probs" in the Western Union office. Later the project passed into the hands of the Western Union and was continued by them. It excited a great deal of interest and comment and when the U. S. Signal Service decided to start a weather service, they came to Cincinnati to have Prof. Abbé help inaugurate it.

It had become evident that the observatory must be removed to a better site, as the growth of the city, with its smoke, dust, and vibrations, had vitiated observations. At this time the university was seeking affiliation with other institutions, and hoped to consolidate them into one. The observatory was glad to co-operate, and a plan was worked out by which the observatory conveyed its instruments and equipment to the city; the Longworth heirs conveyed reversionary interest to the university for the support of the School of Design, which later blossomed into the Art Academy; Mr. John Kilgour gave four acres of land on Mt. Lookout for a site and $10,000 for the building; and the university agreed to support the observatory. It is to be noted the university is owned and operated by the city and about one fifth of its operating revenue comes from direct taxation.

A period of nearly five years elapsed, in which the removal was planned, the necessary legal steps taken, and the building erected. The cornerstone was relaid in 1873 with appropriate ceremonies and in 1875 Prof. Ormond Stone, a member of the staff of the U. S. Naval Observatory, was appointed director. A faculty of the observatory was organized and courses offered in astronomy and mathematics; Prof. Stone was interested



The old 11-inch telescope, with Mitchel at the eye end (from an engraving in "Sidereal Messenger").

in young men and attracted a number to Cincinnati, four of whom later became directors of observatories. These men assisted in making observations, were paid for computing, and the early publications include their observations.

Prof. Stone revived the study of double stars and prepared Mitchel's observations for publication; the great comets of 1881 and 1882 were studied. That the public was interested in the work of our observatory is evident from a facetious clipping from a Chicago paper: "Prof. Stone and Mr. Howe, of the Cincinnati Observatory, report for

the last six months 2,275 observations of double stars. This is a good many stars, for six months, but then the whisky of Cincinnati has wondrous power."

The University of Virginia called Stone to become director of its new Leander McCormick Observatory in 1882, and Stone's pupil, H. C. Wilson, was put in charge until a permanent director could be appointed. Mr. Wilson made a special study of comets and received from the university its first award of the Ph.D. degree for his excellent work.

Dr. Jermain G. Porter took charge of the observatory in 1884: he had been an assistant to Dr. C. H. F. Peters at Hamilton, had spent a year at Berlin under Foerster, and several years in the U. S. Coast and Geodetic Survey. He was interested in the positions and motions of the stars and at once began to observe a zone of stars with the 3-inch Buff and Berger transit instrument (the zone was 3½° wide and its center was at —20½°); in spite of his care, the probable errors in right ascension and declination were large. He was convinced that a better instrument was necessary, and from Fauth & Co. obtained a 5-inch meridian circle in 1888. For the rest of his life, the main work of the observatory was with the meridian circle. Modern positions of stars were obtained and, by comparison with older observations, proper motions were computed. More than 17,000 stars were observed and 7,000 proper motions computed.

A reobservation of the northern stars of Piazzi's catalogue, in co-operation with Lick Observatory, which observed the southern stars, and with Dr. Herman S. Davis, who was to re-reduce the catalogue and compute the proper motions, was begun in 1897. Unfortunately, the results of Davis' re-reduction have never been published.

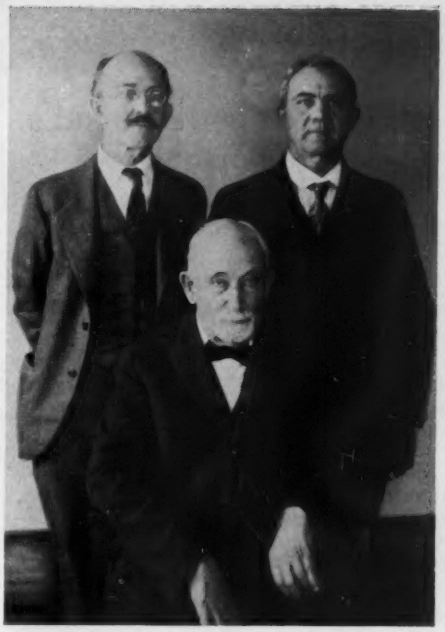
The discovery of the variation of latitude led the International Geodetic Association to undertake its determination, and they selected observatories near the 39-degree parallel in various countries: Cincinnati was asked to co-operate for five years, as it is close to the 39th parallel of latitude; other stations were Carloforte in Italy, Tschardjui in Turkestan, Mizusawa in Japan, Gaithersburg, Maryland, and Ukiah, California. This work was continued for 15 years and abandoned when the first World War broke up the International Geodetic Association.

A 16-inch refractor by the Alvan Clark Corporation was mounted in 1904 and used by Dr. Porter to obtain exact positions of nebulae by making micrometer comparisons with fixed stars whose positions were known.

A second building was erected and dedicated in 1913 — the Mitchel building to house the old telescope and a lecture room for visitors. As the observatory was built by popular subscription, a part of its educational work has always been to entertain visitors, and allow them to look through the Mitchel glass. The people of Cincinnati now have the privileges formerly enjoyed by the stockholders of the old astronomical society.

Dr. Porter's directorate lasted 46 years; he retired at the age of 78 and survived his retirement three years. His successor was his assistant, the author, who retired in 1940; another assistant, Dr. Elliott S. Smith, served the three years, 1940-43 which complete the century of existence of the Cincinnati Observatory. During these years, the work begun by Dr. Porter has been continued and a catalogue of stars, observed by Dr. Smith, is nearly ready for publication. Also orbit work has received some attention, the best known being the orbits computed by Dr. Paul Herget for the satellites of Jupiter recently discovered by Dr. Seth B. Nicholson, at Mount Wilson.

The observatory staff has always offered courses in astronomy at the University of Cincinnati as part of its educational work; it has also considered it desirable to encourage an interest in astronomy on the part of the general public. The democratic origin of the observatory was Mitchel's pride, and his successors have had equal pride in preserving its traditions of serving the public.



Directorship of the Cincinnati Observatory for 59 years was held by these men: Dr. Porter, seated, the author, left, and Dr. Smith, right.

Sauce for the Gander

READERS are asked to send in questions, from which this editor will select the best each month to answer here. The last question is left unanswered, but the reader should be able to find the answer for himself. This month's questions came from E. Norton, Hopkinsville, Ky., and Joseph W. Thomas, of Quincy, Mass.

Q. One of my friends and I have been wondering which are the longest and shortest days of the year, June 21st and December 21st or June 22nd and December 22nd.

A. The dates of the year's longest and shortest days are variable. This is so because, first, the earth's period of revolution is not an exact multiple of the number of days in the year, the seasons gaining almost a quarter of a day over the calendar every year but leap year. From 1897 to 1903 inclusive, there were seven years without a leap year, hence a change in the seasonal dates of well over a day. Second, consider the longest day of the year at two places, one on either side of the international date line. It is evident that although the longest day occurs at practically the same time for these two places, it will have different dates. However, as the **Nautical Almanac** gives its events in Greenwich civil, or Universal, time, this second case would not be apparent by reference to the almanac.

Q. I have noticed in many of the telescopic photographs of the sky that the brightest stars have a cross on them. The points seem to extend north-south and east-west. In the picture of the Great Nebula in Andromeda, a star near the bottom has also a circle around the cross. Can these things be explained?

A. Because light is a wave motion, when it passes close to the edge of an obstruction, it is **diffracted**; in a sense, it is scattered from this edge. A sharp knife edge held before a light will show a sharp, bright line of light along the edge. The spider legs holding the secondary mirror of a reflecting telescope act in this way and produce the well-known "diffraction cross" on photographs. The brighter the star, the larger and more brilliant the cross. In the case of faint stars, the cross is too faint to appear in the photograph. This cross can also be seen on the brighter stars when observing with an eyepiece.

Refracting telescopes do not show this phenomenon because there are no secondary supports; hence, the diffraction cross identifies pictures taken with a reflector. If there are only three legs to the spider, the diffraction cross is six-pointed, as each leg produces a bright line entirely across the image. This is an important reason for using four instead of three legs.

The ring of light around brighter stars is caused by the reflection of light from the back surface of the photographic plate. Plates are placed in the telescope with the emulsion side facing the objective. Light passing through the emulsion to the rear surface of the plate is partly reflected back to the emulsion side and, if the star is bright enough and the exposure long enough, there will be sufficient light reflected back to record on the plate as a ring. Both refracting and reflecting telescopes show this effect on over-exposed images.

L. J. LAFLEUR
Antioch College
Yellow Springs, Ohio

Amateur Astronomers

RITTENHOUSE AND FELS CELEBRATE

MANY of the country's present and former planetarium lecturers were present at the celebration in Philadelphia on November 9th, commemorating the 10th anniversary of the opening of the Fels Planetarium and The Franklin Institute Museum. Mr. James Stokley, first director of the Fels Planetarium and past president of the Rittenhouse Astronomical Society, gave an illustrated talk to the society that evening on the subject, "Bringing the Stars to Man."

A major event of the evening was the awarding of an honorary membership in the Rittenhouse to Samuel Fels, "in recognition of 10 years of fulfillment of the dream which moved him to present the Fels Planetarium to the people of Philadelphia for their education and inspiration." In his absence because of illness, Mr. Fels' physician received the membership scroll.

The Philadelphia philanthropist was also unable to receive personally another honor granted him earlier in the day, that of honorary membership in The Franklin Institute. Two other recipients of this award were Mrs. Mary Curtis Bok Zimbalist and Col. Philip Fox.

The latter, first director of America's first planetarium, gave a special demonstration in the Fels Planetarium that afternoon, an occasion which brought back memories of the days when Col. Fox was daily building the standard for lecture style and content in this country's planetariums. He was the first to dispense with a lecturer's assistant, long the custom abroad, procuring better co-ordination between lecturer and instrument by having the speaker handle the controls.

A highlight of The Franklin Institute program was the awarding of the Vermilye medal to Walter S. Gifford, president of the American Telephone and Telegraph Company.

ASTRONOMY IN THE ORIENT

Miss Louise Jenkins, secretary of the Yale University Observatory, addressed the November meeting of the New Haven Amateur Astronomical Society on the subject "Glimpses of Astronomy in the Orient." Although she is an astronomer, Miss Jenkins spent 11 years in Japan as a teacher of the Bible and English, but with her astronomical background she naturally observed and noted many interesting and strange customs.

She visited the three observatories in Japan, one of which was in the center of the city of Tokyo but later moved 20 miles outside the city limits. It was at one of these observatories that Kemour noted that the earth's center of gravity wobbled slightly, which discovery was cited by the late Dr. Frank Schlesinger as one of the greatest contributions to come out of the Orient.

Japan was very reluctant to accept books, instruments, and the like from the outside world, and in 1638 issued an edict prohibiting the importation of books from any foreigners; for 200 years the country was closed to outside influence.

In 2300 B. C., China was using the gnomon to record the sun's shadow. The Chinese were the first to observe sunspots. The Japanese adopted the Chinese calendar, but changed it five times in less than 200 years, as the calendar did not correspond to the actual length of the year. The first correct Japanese calendar was developed in 1684.

The signs of the zodiac used by the Oriental nations are quite different from ours. The Japanese use the following: Rat, Ox, Tiger, Hare, Dragon, Serpent, Horse, Boat, Monkey, Cock, Dog, Boar; each year is known by a particular sign and their New Year cards all bear the picture of the animal representing it.

F. R. BURNHAM
New Haven A.A.S.

LOUISVILLE CELEBRATION

The physics and mathematics departments of the University of Louisville, as well as the faculty of the Speed Scientific School of the university, were special guests at the meeting on November 16th celebrating the 10th anniversary of the founding of the Louisville Astronomical Society. Among the features of the evening's program were the reading of a history of the society and the showing of astronomical motion pictures.

The Park Board of Louisville, Ky., has dedicated space on a high spot in one of the parks several miles outside the city as a site for a future observatory, to house a 20-inch reflector which the society hopes to complete after the war. Meanwhile, the telescopes made and owned by individual members help to fulfill the desire of the Louisville public to view the heavenly bodies.

NAVAL OBSERVATORY NEEDS JR. ASTRONOMERS

The United States Civil Service Commission is seeking persons qualified to be Junior Astronomers in the Naval Observatory, Navy Department, Washington, D. C. These positions will be filled through the civil-service examination now open. There is no written test and no maximum age limit for this examination. Applicants will be rated on their education and experience. They must have completed a 4-year college course including or supplemented by 12 semester hours in mathematics and 12 semester hours in astronomy. No experience is required, but credit will be given for appropriate experience.

Persons now using their highest skills in war work should not apply. Those unable to fulfill the qualifications above, but who have their bachelor's degrees, are urged to file their applications as Junior Professional Assistants.

THIS MONTH'S LECTURES

New York City: On December 1st, Dr. Clyde Fisher, honorary curator of the Hayden Planetarium, will address the Amateur Astronomers Association on the subject, "Palomar Giant, the 200-inch Telescope." This meeting is open to the public, and is held in the American Museum of Natural History at 8:00 p.m. On December 15th, the regular monthly observation meeting will be held under the guidance of Miss Hazel Boyd.

Detroit: The Detroit Astronomical Society will hear an illustrated lecture by Dr. Russell C. Hussey, associate professor of geology at the University of Michigan, on December 12th. His subject will be the "History of the Cave Man." The meeting place is Wayne University, 4841 Cass Avenue.

New Haven: At the December 11th meeting of the New Haven A.A.S., Olive G. LeRoy will speak on "Novae, the Exploding Stars." This lecture will be illustrated by lantern slides. The meeting is held at Yale University Observatory, Prospect and Canner Streets, at 8:00 p.m.

Washington, D. C.: At the meeting of the National Capital Amateur Astronomers Association on Saturday, December 4th, Dr. Philip C. Keenan will speak on "The Measurement of the Temperatures of the Stars."

OPEN HOUSE NIGHTS IN CLEVELAND

The Case School of Applied Science announces a series of public nights at the Warner and Swasey Observatory, located at Taylor Road two blocks south of Euclid Avenue. The observatory will be open at 7:30 p.m.; the lecture will begin at 8:00; and there will be observing through the telescope after the lecture, weather permitting.

"Sun's Light and Heat" is the title of the lecture on Thursday and Friday, December 9th and 10th. "Mars and its Moons" is the title for Thursday and Friday, January 6th and 7th. For reservations, the public is invited to call GArfield 6680.

The Wise Men's Star

By Marian Lockwood

The origin of Christmas and the possible astronomical source of the Star of Bethlehem are described in the Hayden and Buhl Planetariums during this holiday season.

CHRISTMAS has always been a time of happiness and gaiety — one cannot imagine a long-faced and solemn Christmas. It is a friendly, light-bedecked time when the thought of brotherhood is in men's minds and the wish for peace and good will in their hearts. Christmas has come to mean much, and not to Christians alone, because it stands not only for the birthday of Jesus, but, through and beyond this, for the good will of men, one to the other.

This year's Christmas is bound to be different from most of those that have gone before. Many homes are broken, many familiar loved faces absent, and for millions of men and women Christmas will be another day on the battlefield. But for the fighting men of the United Nations Christmas will not be *just* another day on the battlefield. It will be much more than that. It will be a day when even in the heat of battle they will be thinking especially of home, of the ones they love the most, and of their hopes for the good future for all mankind which should and must come out of their own sacrifice and victory.

On Christmas, too, this year, many men will be thinking of their ideals, men who do not often stop to think of them consciously. And the fighting man will think of peace, a good peace where all the little peoples of the world will have their right to be secure in the pursuit of liberty and happiness. He will believe this Christmas that the day will come, and hope that he may aid in its coming, when men can say: This is a good world, and in it good men can face the future with hope and with the certainty of traveling toward ever broader and more beautiful horizons.

There are many whose sadness will be hard to overcome this Christmas. But they will remember, too, that over the whole planet which we call Earth there shines with steadfast serenity the radiance of the Christmas star, a symbol which has shone across 2,000 years of time, signifying the hope of mankind.

As to the historic reality of the Star of Bethlehem, there are those, of course, who deny that such a thing ever existed, maintaining that the whole story is but a legend and contains no basis in fact. Even these people, however, cannot deny the subjective reality of the star as a symbol and what it has meant to countless millions of human beings.

There are those, too, who maintain that the Christmas star was a miracle, a supernatural event which cannot now and never will be explained by any rational scientific reasoning. To some of these people it is almost sacrilege to consider possible explanations for that celestial apparition of which it was written:

"And, lo, the star, which they saw in the east, went before them, till it came and stood over where the young child was."

Then, many wonder whether there may not be some astronomical explanation of the star which the Wise Men saw in the sky and which they interpreted as a heavenly sign sent to guide them to the birthplace of the Messiah.

Various suggestions as to the possible identity of the Christmas star have been made by astronomers. No one knows

The two brightest objects in this picture of the early winter sky are Mars (upper left center) and Saturn (to the left of Mars). The bright star between the planets is Zeta Tauri, while Beta Tauri forms a triangle with them. To the right are the Pleiades and the Hyades (Aldebaran inconspicuous because of its redness), and in the lower left the whole of Orion. This picture was taken early in October with a Harvard patrol camera.

whether any one of them is correct. The Christmas star remains a mystery today as it has through the centuries, and as it is likely to do until the end of time. The scientific records of early days were very meager and it is almost impossible to check up on any unusual objects that may have been seen. There are certain definite starting points, however, which are known and which must be taken into consideration.

In the first place, no one knows the date of the birth of Jesus, either the year or the date. It has generally been assumed that Jesus was born at the beginning of our era, or 1943 years ago this Christmas. Actually, we know now that He was born at least 1947 years ago, and maybe as much as 1954 years ago, perhaps in the year 4 B. C. or possibly as early as 11 B. C., according to some Biblical authorities. Many experts, however, believe that the correct date is 6 B. C. The uncertainty in the dating of the birth of Jesus comes about through an error made in calendar computations by Dionysius Exiguus, an abbot of Rome in the sixth century.

This means also, of course, that we are not actually living in the year 1943 A. D. (Anno Domini), but in the year 1947 A. D. if Jesus was born in 4 B. C., or in 1949 if He was born in the year 6 B. C.

The time of the year when Jesus was born is also a mystery. Until the end of the fourth century the universal celebration of His birth occurred on what we now know as Epiphany, the 6th of January, which in some places is still called "Old Christmas" or "Little Christmas," though better known as Twelfth-night, the official ending of the Christmas season and the night when Christmas decorations are taken down.

About the end of the fourth century the Christian Church, or the western branch of it, found itself in difficulties because the members of the Church were obstinate in their refusal to give up the celebration of an ancient pagan holiday occurring on December 25th, which the early people considered as marking the winter solstice. This holiday was held in honor of the re-birth of the sun, for at this time, after the short cheerless days and long cold nights, the sun appears to reverse its motion in the sky and again begins to climb upward, lengthening the days and shortening the nights, bringing light and warmth to the world again. (This was true, of course, only for the northern half of the world.) Gentle persuasion had little or no effect upon the erring church members. And the Church, finally, making a virtue of a necessity, declared that thereafter the birthday of Jesus should be celebrated on December 25th, transforming a pagan rite into one of the most meaningful and beloved of Christian festivals.

No part of the Christmas story has so taken hold of men's imagination as has the symbol of the Christmas star. But what was the Christmas star, or what might it have been, according to the astronomical possibilities? In considering these possibilities it must be realized that the word "star" is frequently misused even today, often being applied to any bright object in the sky.

Anyone who has, during the last few months, been watching Venus as a morning star, realizes what a magnificent object it is when it shines most brilliantly. At such times, Venus can be followed across the daytime sky even in full sunlight, if one knows where to look for it. It has been suggested again and again that the brightest of the planets was the wondrous star seen by the Wise Men, and that its light guided them to Bethlehem. There are others, however, who maintain that Venus must have been familiar to these wise men, as it was part of their regular duty to watch the sky for omens, and that they would never have accepted as a sign of the Messiah's coming such a familiar heavenly body. They would have expected as a sign of such an important event a much more unfamiliar object.

That the Star of Bethlehem may have been a particularly bright meteor or fireball has been suggested. Some meteors, particularly brilliant and large, have been known to light up the night as the sun does the day. Obviously such an object would have been of great interest to those who were watching for a sign, but the objection can be raised that the watchers would not have accepted such a passing and ephemeral light.

People who have observed brilliant comets like Halley's, which last appeared in 1910, realize that such an object would have been viewed with the greatest wonder by the early observers, who could have had no notion what a comet really was. Comets sometimes appear as great scimitar-shaped objects of light, and might easily be interpreted by those watching as the finger of God pointing in the direction in which they should go to find the Messiah. Some comets are so brilliant that they can be seen in the daytime. Since we do not, however, know the real date of Jesus' birth it is impossible to check back, and find out whether a comet might have been the Star of Bethlehem.

Every now and then a "new" star appears in the sky, a nova, or a supernova. These are not actually new stars at all, but faint stars which have suddenly become hundreds or even thousands of times as brilliant as they were before. This great increase in brilliance undoubtedly results from some sort of stellar explosion. In 1572 Tycho Brahe became very much interested in one of these new stars which later became known by his name, Tycho's star. It was bright enough to be seen in full daylight. If such a nova as this appeared at the time the Wise Men were watching, they would undoubtedly have thought it a sign from heaven.

One of the most interesting possibilities as to the identification of the Star of Bethlehem is connected with the planets. In 7 B. C., Jupiter and Saturn were in conjunction in the constellation Pisces, the Fishes, which in the thought of that day was sacred to the Jews. Some people believe that this may have been the Christmas star, in spite of the fact that the two planets were distant from each other by more than twice the diameter of the moon and that a similar event had taken place 59 years earlier.

What the star was, no one knows. But the story of its glorious radiance has so engaged the heart of man that he is, nearly 2,000 years later, still speculating on its possible identity.

In Focus

THE PHENOMENON consisting of inversion of the apparent relief of some photographs and drawings, especially those of the moon [such as appears on the back cover], has always interested me. These inversions seem to occur as an occasional subjective phenomenon, without any control on the part of the person looking at the picture.

But, on one occasion, while I was observing a picture of the moon very near to an electric lamp, the inversion took place [floors inside crater rims look like plateaus surrounded by valleys], and a possible explanation occurred to me. It was that the source of light was rather strong and definite, and fell on the photograph from a direction opposite to that of the light which originally illuminated the objects appearing in the picture.

This explanation may be checked by inverting a moon picture, once and again, obtaining always the same corresponding appearances with each relative position of the picture and the light. Agreeing with this theory, the inversion of the apparent relief may seldom occur, and at random, when the picture is observed in a place where the light is very diffused, or coming from all sides with practically the same intensity.

It seems to me that the mind instinctively repels the shadows and illuminated parts of the picture when the light is opposite to the original illumination. The results are yet more striking when the observer has the light in front of him.

JULIO C. ORTIZ
Tamarindo No. 43
Jesus del Monte, Havana, Cuba

Ed. Note: We have observed this inversion of lunar photographs when they are projected from lantern slides, particularly in the well-known Yerkes slide of the lunar crater Theophilus. Sr. Ortiz gives an interesting explanation, although it may not seem to fit one's own experiences in the matter.

NEWS NOTES

By Dorrit Hoffleit

HIDE AND SEEK

Hide and seek: that is the game being played between comets and comet-seeking astronomers. Sometimes, on the hunt for one comet they find another. Thus, Leslie C. Peltier, despairing of finding Comet d'Arrest, turned his telescope to another region of the sky, and in half an hour made an independent discovery of the faint and swift Comet Diamaca instead. So fast, indeed, was Comet Diamaca sneaking away, that American astronomers did not have time to keep up with it; and hence they did not get enough observations to compute its orbit. Fortunately, however, it had been discovered nine days earlier in Europe, whence an orbit computed by Naur reached this country on October 18th.

Meanwhile, Dr. G. van Biesbroeck, Yerkes astronomer observing at Fort Davis, Tex., who had asked Peltier in Ohio to help him search for Comet d'Arrest, himself looked for and found d'Arrest on October 24th. It was a faint, diffuse object, with a short tail, less than a degree long, and so far south (—28°) that Peltier's failure to discover it from a more northern latitude is quite understandable.

Periodic Comet d'Arrest, discovered in 1851, had been "lost" since 1923, though its period of about 6½ years should have brought its return to the earth's neighborhood several times since then.

A NOTABLE PARADOX

Science Service calls attention to an investigation by Dr. Otto Struve, director of Yerkes Observatory, of a star whose spectrum "presents a notable paradox." The star, known as 48 Librae, combines characteristics of both a supergiant and a main-sequence star (the latter more commonplace as regards luminosity). At wave lengths longer than 3650 angstroms, a main sequence *B*-type star is suggested, while at shorter wave lengths the spectrum resembles a supergiant *A*-type star. (*A* stars are cooler than *B* stars.)

Strong metallic absorption lines, which have developed during the past 10 or 20 years, are observed. Some spectral lines arising in the gaseous shell surrounding the star are sharp and strong, while others are diffuse and weaker. Taken all in all, the observations indicate stratification in the tenuous shell surrounding the star. The outermost layers are rotating slowly while inside layers have much higher speeds of rotation. Turbulent motions within the shell are in evidence, and the complexity of the situation is enhanced by the fact that the inner layers seem at times to be expanding, then contracting.

The shell observed surrounding the star Pleione in 1940 resembled the shell of 48 Librae in many ways. Most of the peculiarities are even more striking and more difficult to account for in 48 Librae than they were in Pleione.

RUSSIAN ASTRONOMY

The English publication, *Observatory*, brings a little astronomical news from Russia. In the May issue is a letter from Moscow to the president of the Royal Astronomical Society, signed by A. Joffé (vice-president of the Academy of Sciences, U.S.S.R., and secretary of the Physical and Mathematical Section) and S. Mikhailov (president of the Astronomical Council). The principal plea in the letter concerns the possibility of renewal of the exchange of scientific literature between the two countries; and it looks forward to the revival of the activities of the International Astronomical Union. It notes that many of the younger Russian astronomers are, of course, engaged in war activities, and mentions the death of the variable star observer, N. Floria, and probably also of L. A. Kulik, explorer of the great Siberian meteorite region.

The following quotation tells briefly of much scientific activity and implies much hardship:

"We are developing the time service and issuing astronomical almanacs for the needs of the navy and air forces, we are learning to use the regular observations of the Sun carried on at eight different observatories in the study of geophysical phenomena related with solar activity. Latitude observations, observations for the establishment of a large new fundamental catalogue of faint distant stars, problems of sidereal astronomy, theoretical astrophysics and comet research are also cultivated, notwithstanding the great losses inflicted by the destruction of the famous Poulkovo Observatory, the loss of the observatories at Kiev, Odessa, Nikolaieff, Kharkov, Simeis, Lvov, Wilno and Tartu, some of the instruments of which it was possible to evacuate."

Another article in the same issue gives a short account of the total eclipse of September 21, 1941 — at a time when "the German invasion of the U.S.S.R. was proceeding at an unprecedented and alarming rate." The path of totality extended from the Aral Sea to the borders of China. Observing expeditions were sent by at least eight Russian institutions or observatories, and very successful observations were made.

The August *Observatory* repeats information received by the Astronomer Royal from Prof. S. Belyavsky, of the Poulkovo Observatory. That observatory was evacuated in the fall of 1941 to Tashkent, Central Asia, "where the unusually large number of clear days and nights offers highly favorable conditions for astronomical observations." It is gratifying to learn that some of the Poulkovo instruments had been removed before the damage to the observatory by artillery bombardment and bombing. (See *Sky and Telescope,* February, 1942.) Much repair will be necessary for the eventual restoration of the observatory.

DUTCH SCIENTIST DIES

Famous physicist and one of Holland's greatest scientists, Professor Emeritus Pieter Zeeman, of the Chair of Experimental Physics at Amsterdam University, died at Amsterdam on October 9th at the age of 78, the *Knickerbocker Weekly* reports.

In 1869 Zeeman discovered that the lines in the spectrum of a beam of light passing through a magnetic field are not single, but are broken up into characteristic groups of lines. This phenomenon, known as the Zeeman effect, has been extremely useful in the interpretation of solar phenomena. It proved the existence of powerful magnetic fields in sunspots and around the sun as a whole.

During his lifetime, recognition was several times bestowed on Zeeman. In 1902 the Nobel prize in physics was awarded jointly to him and his associate, Hendrik Antoon Lorentz. Zeeman was the recipient of the Henry Draper medal of the Academy of Medical Science, the medal of The Franklin Institute, and the Rumford medal of the Royal Society of London. Since 1908 he had been a member of the Royal Academy of Science in Holland.

PHOTOGRAPHY AS USUAL

"Astronomy as usual" would not be altogether true, but "celestial photography as usual" does apply to Harvard Observatory's continued studies of the southern sky, made at Bloemfontein, South Africa. The report received recently from Dr. J. S. Paraskevopoulos, superintendent of the southern station, on the activities of the various photographic instruments during the month of June, shows scarcely a trace of war handicap — or weather handicap either.

Of 30 nights, 21 were clear throughout, and only five astronomically useless. Ten instruments, ranging in mirror or lens diameter from 60 inches down to 1.5, took 1,058 photographs involving 1,099½ exposure hours. The 60-inch reflector yielded 61 pictures, probably mostly on faint galaxies; the 24-inch refractor took 81 exposures on galaxies and faint variables.

American Astronomers Meet

By Loraze B. Taylor and Frank K. Edmondson

Kirkwood Observatory, Indiana University

REGISTRATION at the 71st meeting of the American Astronomical Society, on the occasion of the 100th anniversary of the founding of the Cincinnati Observatory, began November 5, 1943, at 2:00 p.m. There was no one present at that time, but shortly thereafter, astronomers began wandering into the spacious halls of the Netherland Plaza Hotel in Cincinnati. They signed the society register at one end of a large dining room on the fourth floor, while at the other end the Council members were trying to carry on a business meeting.

President Harlow Shapley and councilors Dirk Brouwer, Keivin Burns, W. J. Eckert, Dean B. McLaughlin, W. W. Morgan, J. J. Nassau, and Joel Stebbins elected five new members to the society and made other decisions between interruptions. According to the program, the Council members were given a dinner, but the party from Indiana ate at Thompson's restaurant, where one fourth of a pat of butter was served to each customer. This exceeded the amount of butter served to each person at the banquet Saturday night by one fourth of a pat.

Friday evening, a large gathering at the Wilson auditorium was welcomed officially by Dr. Raymond Walters, president of the University of Cincinnati, who read a message from President Roosevelt:

"The founding of the Cincinnati Observatory one hundred years ago was an event of great significance in the march of science and culture in this country. The enormous advance in the science of astronomy since the venerable John Quincy Adams, former President, journeyed to Cincinnati to lay the cornerstone of the original building emphasizes the debt we owe to the Cincinnatians of a century ago whose vision and generosity made possible the establishment of the Observatory.

"May I, in extending hearty greetings, express the hope that the work of the Observatory will go steadily forward and that the sphere of its influence will ever widen in the decades ahead."

Robert L. Black, member of the board of directors of the University of Cincinnati, gave an extremely interesting account of the history of the Cincinnati Observatory. He told of the tenacious way in which Ormsby MacKnight Mitchel, founder of the observatory and later a general in the Civil War, clung to the idea of the greatest telescope in the world, to be bought by the people of Cincinnati, until he had surmounted all obstacles.

The program concluded with an interesting illustrated lecture concerning "A Cycle of Astronomy," by Dr. Shapley. He examined the century's contribution to the question of centers — "the center of the earth, of the solar system, of the Milky Way" — and of the universe itself. He said that the center of our galaxy, some 30,000 light-years away in Sagittarius, is not the center of the universe, for the identification of the spiral nebulae as external galaxies has completely changed the concept of a universal center. Our own galaxy is found to be a few hundred thousand light-years from the center of the local supergalaxy or group of galaxies. But far beyond the bounds of our own local group we have mapped the positions of 500,000 other great stellar systems, and the question before us now is: "Is there a boundary to this overall system, the metagalaxy?" Dr. Shapley concluded his lecture with a description of the researches on these problems and a discussion of alternative hypotheses.

Among the guests of honor at the reception was Alice Roosevelt Longworth, elegant in a purple gown. The first Nicholas Longworth, grandfather of the late Speaker of the House, had donated the ground on which the first observatory was built. Rumor, in the person of Cincinnati's Mayor James Garfield Stewart, has it that the Longworths received the land originally in exchange for a still. (Mayor Stewart thinks it may have been his own ancestors who gave up the land for the apparatus.)

The Saturday morning meeting was held out at the observatory, located on Mt. Lookout in the eastern part of the city. There were those (we blush to say) who had to take a taxi after oversleeping, and who had difficulty in finding the observatory anyway. An innocent bystander at the corner, who was the only person within a radius of several blocks who knew where the observatory was, later turned out to be Everett C. Yowell, son of the retired director of the observatory, and a graduate student in astronomy at Columbia.

Dr. Paul Herget, newly appointed director of the Cincinnati Observatory, welcomed members and gave a brief account of activities of the past year; he mentioned that 2,000 visitors had been at the observatory during that time.

Announcement was made that the Council had voted to award the Annie J. Cannon prize for women astronomers to Miss Antonia C. Maury, now of Hastings, N. Y., for her distinguished work at the Harvard Observatory in the early days of spectral classification.

Due to the comparatively sparse wartime program, papers were presented without benefit of alarm clock, darkroom timer, buzzer, or other restraining devices. A system of priorities was set up by which preference was given to members in attendance, in order of their

Members and guests at the 71st meeting of the American Astronomical Society, Cincinnati, November 6th. At the extreme left is Dr. Paul Herget, newly appointed director of the Cincinnati Observatory.

appearance on the program. Most of the papers were vigorously discussed during, as well as after, their presentation. The small, but enthusiastic group present and the unusually informal air of the meeting made it seem more like a colloquium than a formal meeting.

At noon the society photograph was taken on the front steps of the Mitchel building. The first picture was a solemn one; the second, more gay. It is shown here. Statistical astronomers probably can analyze the distribution of smiles and determine the identity of the person causing the hilarity. For the benefit of others, we point out that the magnitude of the smiles is inversely proportional to the square of the distance from the editor of this magazine.

Luncheon was served at the Knox Presbyterian Church, approximately a mile from the observatory. Members vigorously applauded the ladies of the church who prepared and served the meal. Dr. Edward W. Stimson, the "five feet, 18-inch" pastor, entertained with anecdotes of the difficulties encountered due to his height.

Before the afternoon session the observatory was open for inspection by those interested. The original cornerstone drew many admirers.

Dr. Stebbins, retiring president, gave an address on "The Law of Diminishing Returns." He pointed out that this law, which is often quoted in agriculture and economics, also applies to astronomy. As telescopes are made larger and larger, there is less than a proportionate increase of power. The practical limit of refractors was reached 50 years ago, with the 40-inch Yerkes telescope, and the 200-inch reflector will be the largest for a long time to come. He used some of his own work for examples of the operation of the law, and pointed out that those who are doing real research are likely to be in difficulties most of the time. He reminded the younger members that "despite the law of diminishing returns it takes only a slight improvement over what has gone before to open up entirely new opportunities. If you can't do something better you can do something different, and either something better or something different will always be welcome on the programs of the society."

The symposium on Dwarf Stars and Planet-like Companions was a most worthy feature of the meeting. It began with a paper by Dr. Everett I. Yowell, of Cincinnati, on the development of observations of the proper motions of dwarf stars. This was followed by papers prepared by Dr. W. J. Luyten, University of Minnesota; Dr. A. N. Vyssotsky, Leander McCormick Observatory; Dr. Peter van de Kamp and Dr. K. Aa. Strand, Sproul Observatory; and Dr. Henry N. Russell, of Princeton University.

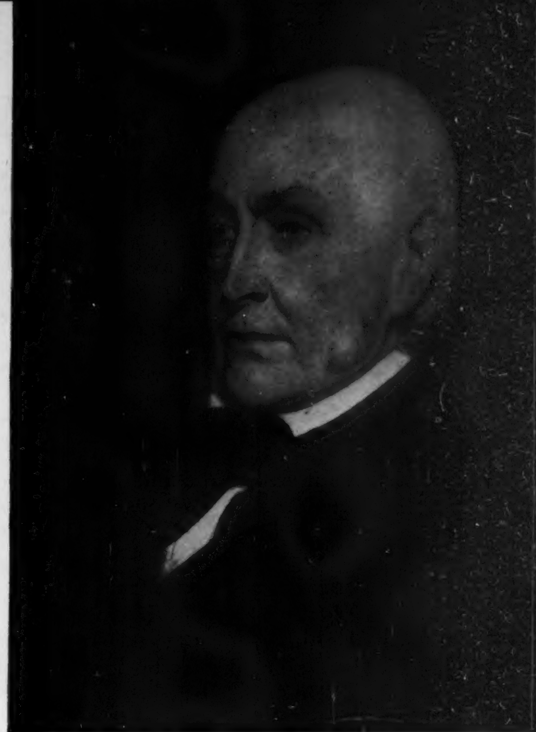
In the course of his study of proper-motion stars, Dr. Luyten has examined 25 million stars on Harvard plates, and has found at least 100,000 stars with measurable motions — all probably within 300 parsecs of the sun. This method is much faster than the parallax method for finding intrinsically faint stars.

Dr. Vyssotsky reported on investigations made in collaboration with his wife, Dr. Emma Williams Vyssotsky, of the motions and distribution of dwarf stars. From spectroscopic criteria, it is possible to find *M*-type dwarfs without any previous knowledge of their motions. This is very important statistically, because it avoids the usual selection effects introduced when dwarf stars are found from the sizes of their proper motions.

Dr. van de Kamp presented his own paper and that of Dr. Strand, dealing with the astrometric studies of unseen companions of single and double stars, respectively. The Sproul Observatory is making a systematic photographic study of all stars within 10 parsecs (33 light-years) and within reach of the 24-inch refractor. Deviations from uniform (proper) motion are already indicated for several stars. Previous observations of this sort made at Sproul include the planet-like companion of 61 Cygni. Dr. Strand writes: "Hertzsprung claimed that the first World War caused him to do his double star work, as otherwise the large Potsdam refractor would have been left idle. The second World War stopped my work, but I hope to start it again after the war and I hope others will join us."

Discussion that afternoon was even more active than it had been during the morning, indicating that much more work needs to be done before our methods of the observation and discovery of dwarf stars and small companions can be standardized.

At the society dinner that evening, Dr. Shapley introduced Mayor Stewart, who kept his audience in an uproar of laughter for 15 minutes or so, but ended on the serious note that the citizens of a democracy can and will support science and the arts better than can despots and dictators, a theme which dates back to



This portrait of John Quincy Adams hangs in the observatory for which he laid the cornerstone a century ago.

the early days of Cincinnati and its observatory.

Brief speeches were made by Dean George Barbour, of the Liberal Arts College, and by Dr. Herget. Presidents of the two amateur societies in Cincinnati, Alfred Hasemeier, Cincinnati Astronomical Society, and George M. Gasper, Cincinnati Astronomical Association, spoke on behalf of their organizations. Dr. Shapley, in assuring those present that amateur astronomers made many important contributions to the advancement of science, cited as instances the retired banker and the retired clergyman who are now making lenses for war purposes.

The appreciation of the society to the University of Cincinnati and all others who had helped to make the meeting a success was expressed by Dr. Eckert, whose remarks brought the evening gathering to a close.

Sunday morning, at its breakfast meeting, the Council elected Dr. H. Spencer Jones, Astronomer Royal of England, as an honorary member. It was also decided that the new format of the *Astronomical Journal* will be like that of the *Physical Review*.

The concluding session began with the presentation by the secretary of the final symposium paper by Dr. Russell. The remaining papers provoked further interesting discussion, as will be evident from the reports by the editors which will appear in this journal next month.

All of those fortunate enough to attend the meeting left with pleasant memories of hospitable Cincinnati and feelings of superiority as possessors of off-the-record comments and hints of military secrets.

The entrance to the Fels Planetarium of The Franklin Institute.

THE PLANETARIUM

By Roy K. Marshall

Fels Planetarium, The Franklin Institute

PART II

THE PLANETARIUM is, as we have seen from Dr. Bauersfeld's statement of the proposition, essentially a multiple projector with which it is possible to reproduce the appearance of the sky for any moment of the past, present, or future, as seen from any spot on the earth. Its operation and product are not, as many suspect, the same as that of the *motion* picture, or a picture in which we see motion. Rather, we may properly speak of the result of the instrument as a *moving* picture, inasmuch as the whole picture which is projected is moved.

To answer an often-asked question first, there is a grand total of about 9,000 star images projected, but it is not necessary to have a separate projector for each one, any more than it is necessary to use three cameras to take a group picture of three people. One lens can be used to take, or to project, many images, and in the planetarium there are 32 projectors to show the images of all 9,000 stars, down to stellar magnitude 6.5, the faintest visible to the unaided eye under superb conditions.

The plates which bear the star images to be projected are not photographs of star fields but are, instead, made of thin copper (really copper foil, little more than half of a thousandth of an inch thick) perforated with holes of various sizes for the stars of various brightnesses. The smallest such hole is nine ten-thousandths (0.0009) of an inch in diameter; the largest is only three one-hundredths (0.03) of an inch in diameter. In all, 65 sizes of punches were used to form these holes, in order to provide a very faithful representation of the relative magnitudes of the stars.

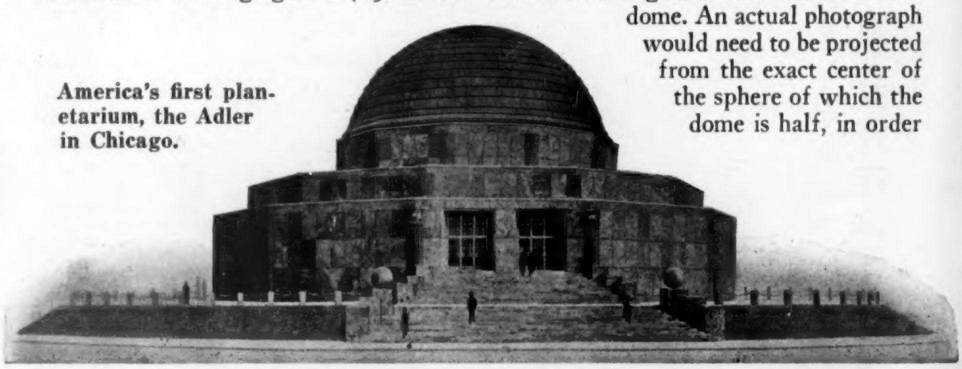
These 32 star fields are so arranged that they would form a continuous spherical picture on the inside of a globe, if all of them operated at one time. Each star plate is flat, however, and forms one face of an interesting geometrical figure. A regular icosahedron is a solid figure with 20 equilateral triangular faces and 12 corners. When the corners are cut off, 12 pentagons are formed, and the original triangular faces become hexagons. This is what has been done to arrange the 32 star fields to fill the sphere; 20 of them are hexagons and 12 are pentagons.

In each of the large globes (29 inches in diameter, made of brass only 0.078 of an inch thick) at the ends of the dumbbell-shaped portion of the instrument there are 16 star-field projectors. The celestial equator is the average dividing line between the projections from the two globes.

In the center of each globe is a 1,000-watt lamp of critical design (now manufactured especially for the purpose by the Westinghouse Electric and Manufacturing Company), with a filament so draped that an equal amount of light is emitted in all directions except toward the base, where it will not be used anyhow. For each star-field projector, a condenser with non-spherical surfaces picks up from the lamp a 30-degree cone of light which passes through the perforations of the star plate, then through an f/4.5 Tessar-type projection lens of 4.72 inches focal length. The star plate is magnified more than 80 times when its image reaches the dome, so great precision in perforating the plates is necessary. But the work of punching the plates is done by hand!

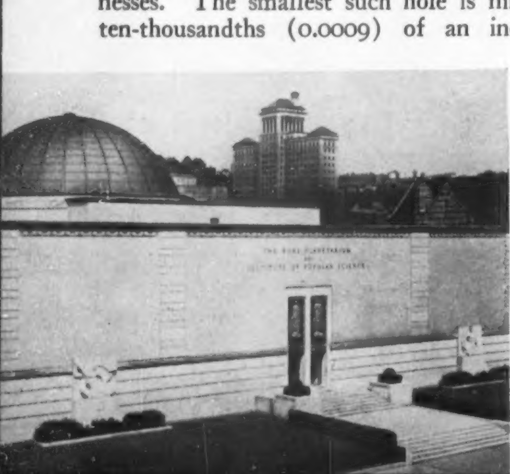
There are two very important reasons why computed star charts and not actual photographs of the sky must be used for the star plates. In the first place, the range of stellar brightness which must be represented is very great; the brightest star shown from one of the plates is more than 850 times as bright as the faintest. The human eye is able to embrace this range of brightness, but no photographic emulsion known will permit the faint stars to be photographed without a very serious overexposure for the bright ones.

But the more subtle reason for man-made charts instead of photographs is the fact that no one of the star projectors is in the geometrical center of the dome. An actual photograph would need to be projected from the exact center of the sphere of which the dome is half, in order to avoid distortion. But the globes which carry the star-field projectors are at the ends of the dumbbell portion of the planetarium, about four feet from the center of the dome, so the star-field charts had to be distorted in advance in order to ensure no distortion in the final result on the projection screen.

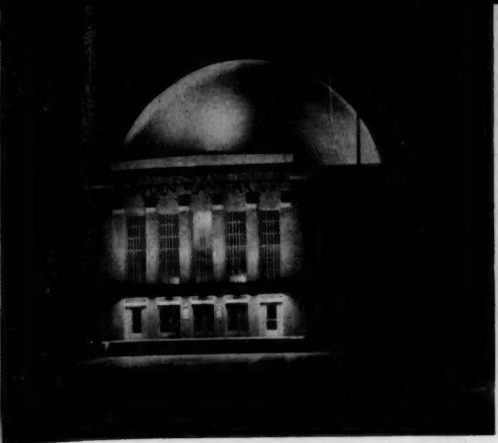


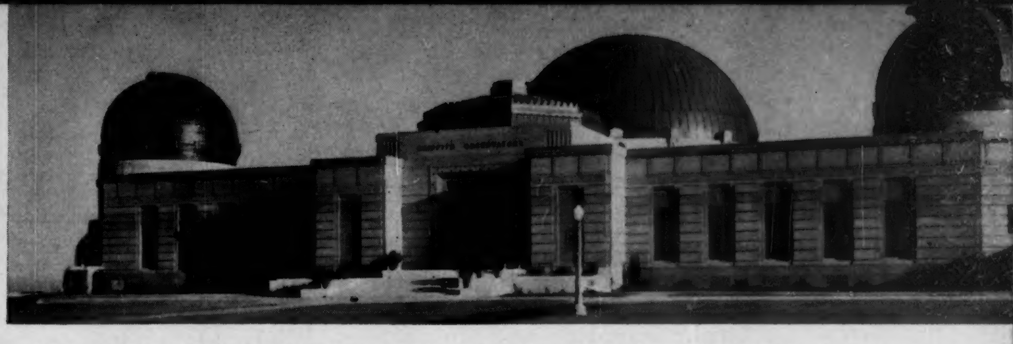
America's first planetarium, the Adler in Chicago.

In nature, all stars appear to be of the same size but of different brightnesses, for all the stars are so remote that their sizes are not directly discernible with even the world's largest telescopes. But in the planetarium, greater brightness is shown by greater size of image on the dome. The faintest stars have disks only 1/16 of an inch in diameter; the disks of the brightest ones have diameters of more than two inches. Sirius, the Dog Star, the brightest star in all the sky, would have an image even larger, so a separate projector has been provided for it; its apparent brightness in the planetarium is attained both by size and brightness of image. This departure from nature, representing dif-



The Buhl Planetarium and Institute of Popular Science, Pittsburgh.





Above: the Griffith Planetarium in Los Angeles, with its two observatory domes. Left: the entrance to New York's Hayden Planetarium.

ferent brightnesses by different sizes, is not often noticed in the planetarium, and is never very bothersome.

In addition to Sirius, three other stars have individual projectors. They are Algol (in Perseus), Mira (in Cetus), and Delta Cephei, the type-stars of three classes of objects which vary in brightness. Each of them is controlled by means of an individual rheostat, so they may be made to go through their variations as in nature.

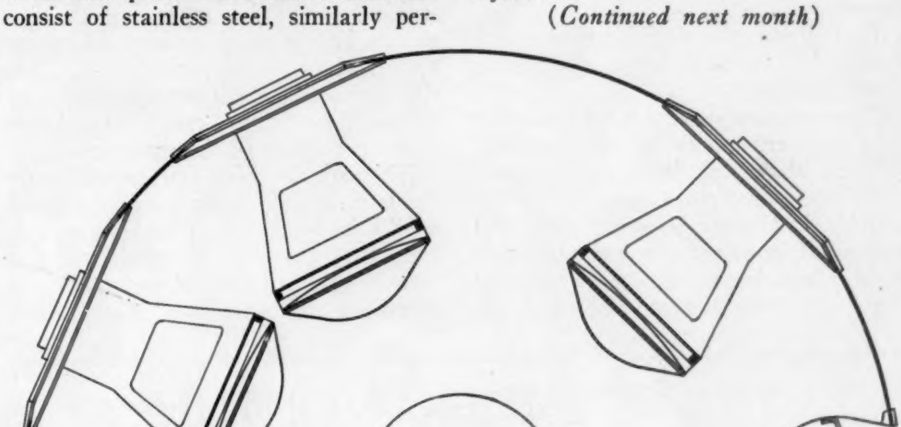
The powdery, irregular path of the Milky Way is reproduced by two cylindrical drum-like projectors, one on each of the star globes. Two negative films were made, one for the northern, the other for the southern half of the Milky Way, by photographing a carefully prepared drawing made by stippling of proper intensity. Each of these films is wrapped around to form the curved surface of a cylinder, and a lamp is placed in the middle to project the diffused image of the Milky Way with all its intricately mottled structure. In nature it consists of the blended light of millions of stars too faint because of distance to be separately distinguished; in the planetarium it is blended of a great multiplicity of diffused points of light, so the appearance of nature is simulated.

Another question often asked concerns the 4-inch-long cylindrical objects (like black fountain pens) which hang below the star-field projection openings. These are important in the occulting mechanisms. It is desirable to have stars shining only overhead, and not on the walls, the floor, and in the laps of the visitors! So some means had to be devised to make the stars and other objects set at the western horizon and not show again until rising above the horizon in the east.

This has been accomplished in the planetarium by a combination of devices as simple as they are effective. Most important is an upside-down eyelid device which covers the projection lens of a star field by coming over it from the bottom, as the particular projector becomes horizontal due to the motion of the instrument. This action is very similar to that of the eye of a doll which "sleeps" when it is laid down. The eyelid is suspended on very delicate pivots, so its motion is exceedingly smooth and precise. But the line of these pivots must be kept exactly horizontal, and this is accomplished by mounting the whole eyelid mechanism in a ball-bearing ring; the cylindrical objects resembling fountain pens are tubes, partially filled with mercury, which act as weights to turn the ball-bearing rings to such positions that the eyelid pivots are always horizontal.

There is even more to this scheme for making the stars set at the horizon. The buildings of the skyline are cut out of the steel plates at the rim of the dome; the buildings are not there! In Chicago, the stretched linen dome has a lower margin of steel, and a similar arrangement is provided for the acoustic tile dome in Los Angeles. In Philadelphia, New York, and Pittsburgh, the entire hemispherical dome is made of stainless steel, painted. In order to prevent the objectionable echoes which would occur if the surface were continuous, the steel is perforated with holes 1/16 of an inch in diameter, about 1/5 of an inch apart. The wall surfaces also consist of stainless steel, similarly perforated. In the 66-foot dome of the Fels Planetarium there are approximately 20 million holes. About 10 per cent of the sound passes through the holes and is absorbed by special acoustic padding behind the dome. These small holes do not interfere with the star images which are projected on the painted steel, but when the instrument has turned until an image is at the horizon, the skyline is encountered. Inasmuch as the buildings have been cut out, there is no projection surface for the stars to shine on, and the light passes beyond the line of the dome to strike a glossy black screen, tilted to deflect the little bit of reflected light downward and lose it. Only the brightest objects can be followed all the way to the horizon, however, for the gradual closing of the eyelid of a star projector causes the stars to fade as they approach the horizon, much as in nature where the longer air path dims the light of a rising or setting object.

(Continued next month)



In each star globe, 16 star-field projectors are fed by a single 1,000-watt lamp. The filament of the lamp has a special drape to produce uniform illumination over more than a hemisphere; thus, the star images are all of the correct relative brightnesses.

BEGINNER'S PAGE

By Percy W. Witherell

Man and His Expanding Universe — I

WHEN the little child stands up in his high chair, the small boy climbs a tree, the adult rises in an elevator to the tower of the Empire State building or drives up the road to the top of Pike's Peak, when the aviator ascends far above the earth, part of the accompanying thrill is due to the enlargement of the individual's horizon and the realization that still "greater worlds to conquer" are just beyond his present knowledge. He is inspired with the hope that the future may reveal more of its latent mysteries.

Before the development of a mentality that was capable of grasping abstract ideas, it was natural that man should endeavor to explain all natural phenomena in the terms of the physical world with which he was familiar.

Hence came the various myths to account for the rebirth (rising) and the death (setting) of the sun. In Egypt, various figures with their respective names symbolize the sun in its daily position in the sky. Horus was the rising or morning sun; Ra, the noon sun; and Tem, the western or setting sun. Osiris related to the daily death of the sun when it had set. Amen-Ra indicated the summer solstice, and there were other dieties for other positions of the sun.

In Babylon, the sign for God was a star and in ancient Egypt three stars represented gods.

Egyptian astronomers were known as "the mystery teachers of Heaven." Records show that observations were made over 7,000 years ago. Besides the wonder and worship with which the priesthood endowed the celestial mysteries, their observations had a practical use. The very life of the nation depended on knowing the date of the overflowing of the Nile, in order to be sure that the land was plowed and the seed sown in time. It is hard for the modern world to realize the difficulties it would face without the ever-available calendar.

The beginning of the overflow of the Nile occurs near the time of the summer solstice. From their past observations, the early astronomers knew that the solstice would be a known number of days after the date that a certain bright star (usually Sirius) set a number of minutes after the setting of the sun. However, because various stars were used at different observatory sites and at different periods, it has been possible to calculate the date when some of the recorded observations were made, and so to correlate the dynastic date with our modern calendar.

The obelisks in Egypt could be used as gnomons. When their shadows were the shortest, the sun was on the meridian, indicating noon. Also, on the day when the shadow was shortest, the sun was highest and the summer solstice was reached. By watching the shadow as it shortened in advance of this time, the exact day of the solstice was accurately determined.

Those early astronomers knew the positions of the sun, moon, and the five planets known at that time: Mercury, Venus, Mars, Jupiter, and Saturn. They also had made rough approximations of the positions of the stars. They knew of the precession of the equinoxes.

Although the priest-astronomers knew the true length of the year and could predict its beginning at the summer solstice, they kept the knowledge of this "sacred year" to themselves and let the people use a "vague year" which began at various times of the true year and only coincided after a long cycle of 1,460 years. This is known as the Sothic cycle, named after Sirius, or Sothis.

In order to maintain their authority and power over the populace and the ruling powers, the priesthood veiled their astronomical knowledge in mysterious rites.

One of their ingenious methods was to construct a temple with a long axis (1,500 feet long in the solar temple of Amen-Ra at Karnak) so oriented that at the summer solstice the setting sun would shine through the entire length of the temple and illuminate a golden image in the sanctuary. By progressively reducing the size of the openings (18 in the above temple) of the various gates, doors, and curtains from the outside of the temple to the innermost sanctum, all extraneous light was excluded, and a very brief but brilliant flash would indicate the exact time of the new year.

With all the congregation facing the sanctuary in a dim light, and the ritual working up to its climax, the faithful followers did not see an illuminated golden image but the presence of Ra himself in the sanctuary.

The Egyptians were familiar with the constellations visible from their latitude and knew that some never set. Sesheta, the star goddess, bore a seven-pointed star mounted on a rod on top of her headdress. In a hymn to Osiris they sang:

"The ever-moving stars are under obedience to him, and so are the stars that set."

The sky was Nut, represented as a female figure bending over Geb, the earth, with her feet on one horizon and her fingertips on the other. Between the two, Shu, the god of air or sunlight, presided. Nut is sometimes symbolized by a row of stars along her back. At other times there is added a band of water. You may recall the Old Testament idea of the firmament in the midst of waters, those above being separated from the waters below the firmament.

ASTRONOMICAL ANECDOTES

STAR OF BETHLEHEM?

READERS of this department doubtless have noted that from time to time hallowed myths, repeated and perpetuated despite reliable facts to the contrary, have been challenged and sometimes refuted. Much of the so-called astronomical "explanation" of the Star of Bethlehem falls into this class. Astronomy is a more-or-less exact science, and even when dealing with such an uncertain topic as the Star of Bethlehem, those who love astronomy should try to adhere to the facts.

For example, the unfortunate emphasis upon a comet of 4 B.C., mentioned only by Pingre, always crops up. Other comets of antiquity were observed in Europe, but not that one. I believe the observational status of that object is somewhat uncertain.

Herod is said to have died after an eclipse of the moon visible at Jerusalem, and, of course, the birth of Jesus must have occurred before the death of Herod. The eclipse is supposed to have happened before a certain feast, usually assumed to have been the Passover. Hence we must look for an eclipse of the moon shortly before, say, the end of March. From lists of eclipses, we find one of the moon on March 13, 4 B. C., and many therefore jump to the conclusion that the birth of Jesus must have preceded that time.

But this eclipse occurred at 3 a.m. in Jerusalem, and was of magnitude 0.37; about one third of the moon's diameter was in the earth's shadow. Would this eclipse have been considered important? It is even unlikely that it was predicted, so it might well have gone unobserved.

How about other eclipses? There was a total eclipse January 20, 2 B. C., and a very long one on January 9, 1 B. C. (chronological), that began at 10 p.m. and ended at 2:30 a.m., in Jerusalem. This is much more likely to have been observed. It is only a couple of months earlier in the year than the observance of Passover. Why could not the death of Herod have occurred in 1 B. C.?

It is when the astronomical explanations center around Kepler that the situation really becomes complicated. To quote from two different portions of the December, 1942, *Sky and Telescope,* we have these statements: "In 1604, he [Kepler] observed the apparent coming together of three planets, Jupiter, Saturn, and Mars, the three forming a small but spectacular triangle in Pisces." "Kepler . . . suggested . . . a rare configuration of these three brilliant planets." The inference is that Kepler considered it possible that this grouping of three planets might be a suitable explanation of the "star," and sometimes, because the statement of this untruth has been so carelessly worded, it has even been said that the three planets blended into a single bright star!

What did Kepler say? The Rev. W. Burke-Gaffney, S.J., now of St. Mary's College, Halifax, Nova Scotia, examined this question very thoroughly in the December, 1937, issue of the *Journal* of the Royal Astronomical Society of Canada. His conclusions, which will be arrived at below, were that almost all popular conceptions of what Kepler said are erroneous.

On Christmas Day, 1603, Kepler observed Jupiter and Saturn, and computed that the conjunction must have occurred on December 17th. On September 26, 1604, there was a conjunction of Mars and Saturn (three degrees apart); on October 9th, Mars passed Jupiter (two degrees apart). On October 10th, Sunday, Johann Brunowsky saw the nova, which Kepler did not see until a week had passed (clouds prevailed). It became brighter than Jupiter, and was last seen in the evening sky on November 16th. It was again visible before sunrise on January 3rd, but it had faded. Kepler last saw it in the evening on October 8, 1605; he looked for it in the morning sky in January, 1606, but he never saw it again.

In 1606, Kepler published *De Stella Nova in Pede Serpentarii.* Then he ran across a book by Laurence Suslyga, of Poland: *Verificatio seu Theoremata de anno ortus et mortis Domini.* . . . On September 6, 1606, in a letter to Johann Barwitz, Kepler wrote, "If the author is correct, in order to reckon the Age of Christ, four years must be added to the Epoch of Christianity now in use. It would follow, therefore, that Christ was born over two years after the great conjunction of the three Superior Planets in the first part of Aries or the end of Pisces, occurring for the sixth time since the foundation of the world. Hence, *the star which led the Magi to the manger of Christ,* if it occurred two years before the birth of Christ, *could be compared with our star.*" The italics are mine. This passage clearly indicates that Kepler is thinking of a nova as a possible Star of Bethlehem, not the great conjunction.

Then he wrote his book *De Vero Anno quo Aeternus Dei Filius Humanam* . . . (1614), in which he said, "Granted, then, that the new star of the Magi was first seen not only at the same time as Saturn and Jupiter were beheld each in the other's vicinity, namely in June B. C. 7, but also in the same part of the sky as the planets . . . what else could the Chaldeans conclude . . . but that some event of the greatest importance was imminent?" Note that Kepler fails to mention Mars in this passage; he refers only to Jupiter, Saturn, and a nova.

It was Ludwig Ideler, in his *Handbuch der mathematischen und technischen Chronologie* (1825-26), who said that, according to Schubert, of Petersburg, a Lutheran Bishop Muenter first had the idea that the *three* planets, Mars, Jupiter, and Saturn, were the "star" of the Magi; then Ideler said (with no authority) that Kepler had earlier advanced the idea.

Kepler's and Ideler's dates of the three conjunctions of Jupiter and Saturn were not in agreement; only one of Kepler's, and none of Ideler's, was correct. In 1856, C. Pritchard computed the dates as May 29, September 29, and December 4, 7 B. C.; the positions lie between 15½ degrees and 21 degrees of the sign of Pisces. In late February, 6 B. C., Mars formed a triangle with the other two planets. But the sun was too close, and certainly Mars and Saturn were not visible!

There were two apparitions of the Star of Bethlehem, one to start the Magi on their way, one to lead them to Bethlehem, after they had spoken with Herod. It was Kepler's firm conviction that the best explanation could be found in two apparitions of a nova, one in June of 7 B. C., the other in February of 5 B. C. He nowhere says that the grouping of three planets alone could be taken as the "star."

R. K. M.

GLEANINGS FOR A. T. M.s

Notes on Mountings

WE RECEIVE many inquiries about telescope mountings, and are herewith answering them en masse, so to speak. Unless one has the great good fortune to find a suitable telescope mounting for sale, he might as well give up the idea of buying one ready made, since they are not produced for the market. And unless he has a large enough pocketbook to buy one made to order ($75.00 and up), the amateur is reduced to the necessity of making his own.

This brings up the problem of how to design and construct a telescope mounting. There are, of course, an infinite number of variations of type, and one can expend as much time and money in refinements and accessories as desired. However, stripped to its bare essentials, a telescope mounting is a very simple mechanism.

Undoubtedly, an equatorial will be desired, since there is no astronomical purpose, with the exception of comet hunting, for which the equatorial is not infinitely superior to the altazimuth mount. And it is no more difficult to construct.

Ignoring the telescope tube itself (which deserves separate consideration), the common or German type of equatorial consists of three parts: the base, the polar axis, and the declination axis.

The German Type

The base: If the amateur intends to use his telescope in only one location, he should provide a metal or concrete pier, set immovably into the ground. For protection of the working parts, he may either make them demountable from the pier and carry them inside after use, or build an observatory, as suits his fancy. If the telescope is to be transported from place to place, a tripod is, of course, required, but it should be solid and sturdy.

The base must be high enough to permit the telescope to be pointed at the zenith without the tube hitting the ground, but should not be of such a height that the eyepiece is not easily accessible.

The polar axis: This is attached to the base and is inclined to the horizontal at an angle equal to the latitude of the location, so as to point at the celestial pole. The accuracy necessary in this setting depends upon the use to which the telescope is to be put; one degree is close enough for general visual observation, but for photography, it must be as nearly perfect as possible.

The axis consists of the shaft and its bearing. The size of shaft depends upon the weight it must carry, but it is far better that it be too large than too small. Cold rolled steel 1½ inches in diameter is a good size for a 6-inch reflector — other sizes should be in proportion. Hollow shafts, such as pipe, require larger diameters for rigidity.

There are several types of bearings which are suitable. Ball or roller bearings are best, but expensive. Bronze bushings (preferably oil-impregnated) are very good, as are babbitt bearings, which one may pour himself, if he knows how (see The SKY, May, 1941). Conical bearings are excellent, but should not be attempted except by an expert machinist. Have the shaft ground, if possible. If not, it must be carefully trued and polished with very fine emery cloth.

A collar is provided at the lower end of the shaft. A worm gear may be added for slow motion or clock drive. This should be mounted with a friction clamp, and the worm and worm gear carefully lapped to avoid backlash.

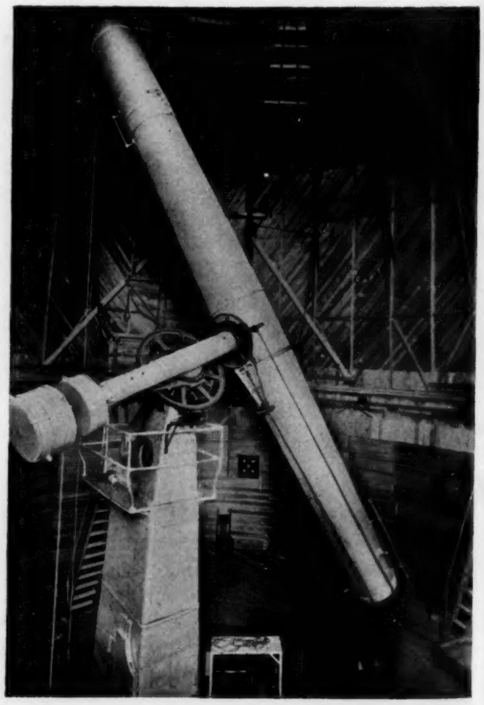
The declination axis: The housing is mounted on the upper end of the polar-axis shaft, and is at right angles thereto. The accuracy of this setting is subject to the same criteria as that of the polar axis. The diameter and length should be the same as the polar axis.

The telescope tube is mounted, in a suitable saddle, on one end of the declination-axis shaft, and a counterweight on the other end, to obtain perfect equilibrium about the polar axis. The tube itself must be in equilibrium about the declination axis.

The tube should be far enough from the declination bearing to clear the polar axis. When the telescope is pointed at the celestial pole, the polar, declination, and optical axes should all lie in the same plane.

Graduated setting circles may be provided on one or both axes. The declination circle is permanently set; the polar-axis circle may be permanently mounted on the polar shaft, with a pointer mark on the stationary part of the mounting, in which case the circle reads hour angle; or it may be mounted to the worm gear of a clock drive, with a pointer mark on the movable polar shaft, in which case it is adjustable and reads right ascension directly.

Advantages: This is the most common



EDITED BY EARLE B. BROWN

and most economical type of mounting for moderate-sized telescopes, and is used almost exclusively for refractors, however large.

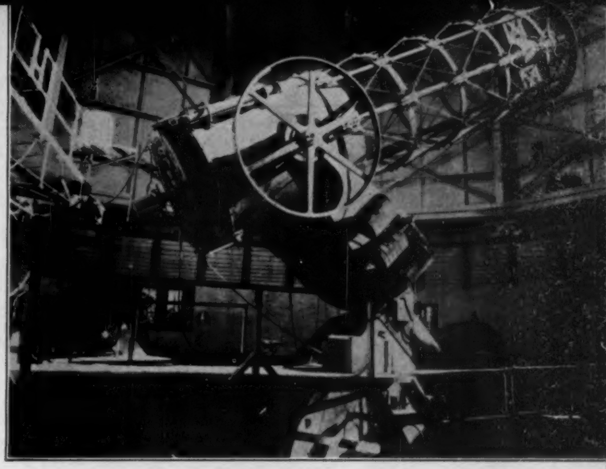
Disadvantages: The weight is unequally distributed on the polar axis, objectionable only in large and heavy telescopes; and the telescope tube must be swung from one side of the pier to the other when passing the meridian, else it will strike the pier. Since photographs are usually taken during meridian passage, this type of mounting is unsuitable for photographic instruments.

Examples: Any large refractor. The Bruce doublet at Yerkes is a modified type, where the objectionable change-over at the meridian is eliminated by offsetting the polar axis from the pier.

There are several other types of equatorial mountings which might be briefly described.

The Fork Type

Here the polar axis is a fork, with the tube swinging between the tines.



Pictured on the opposite page is the 24-inch Clark refractor of Lowell Observatory, with a German-type equatorial mounting. At the right is Harvard's 61-inch fork-mounted reflector. Below is the 13-inch Lowell photographic telescope with which Pluto was found. It has a cross-axis type of mounting.

Advantages: No change-over is necessary at the meridian, and no counterweight is necessary. This type is ideal for Schmidt cameras. The tube is better balanced than in the German type.

Disadvantages: The fork must be heavy and well braced to avoid flexure. The unequal weight distribution of the German equatorial is still present. This type is suitable only for very short telescopes unless the tube is heavily weighted at the lower end.

Examples: Harvard Observatory's 61-inch; Mount Wilson's 60-inch.

The Yoke Type

The polar axis is a yoke composed of two parallel beams, between which the tube is swung. There is a polar-axis bearing above and below the tube.

Advantages: Equal weight distribution on the polar axis.

Disadvantages: This type has a blind spot in the north, a triangle extending from several degrees above the pole to the horizon.

Examples: The 100-inch Mount Wilson instrument. The 200-inch at Mount Palomar is a modified version, eliminating the blind spot.

The Cross-axis Type

This is the same as the yoke type, except that the tube is mounted across instead of in the polar axis.

Advantages: The pole has been made visible, and weight on the polar axis is the same in all positions.

Disadvantages: There is still a triangular blind spot, extending from the pole to the horizon, and the declination axis must be counterweighted.

Example: The 15-inch U. S. Naval Observatory telescope.

There are other types, such as the Coudé, turret, and Springfield mounts, of which there are fewer professional examples. Most of these are for special purposes.

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

BOOKS AND THE SKY

THE ASTRONOMICAL TABLES OF THE MAYA

Maud Worcester Makemson. Carnegie Institution of Washington, Contributions to American Anthropology and History, No. 42, **Publication** 546, pages 183-221.

THE MAYA civilization, which flourished in Central America from before the Christian era to the time of the Spanish conquest, included among its cultural elements a notable development of astronomy and a remarkable system of chronology. As far as is known, Mayan astronomical knowledge developed independently of any contacts with other nations (though speculations to the contrary have been advanced by some writers). Mayan astronomy is therefore of particular interest in the comparative study of the formation of astronomical concepts among different native peoples; and it should have an especial appeal to many amateurs, because the phenomena and the observations that lead to the spontaneous development of astronomy in a primitive civilization are mostly familiar and still of interest to the amateur, although many of them have lost their importance for the professional astronomer. The associations that these phenomena have with the ideas, the legends, and the customs of immemorial ages in all the lands of the earth, some of which survive to this day, contribute an important element to the fascination and romance of the heavens.

The Maya writings are in hieroglyphic characters, the majority of which are still undeciphered; those of which the meanings are known relate principally to numbers, calendar dates, and astronomical phenomena. Moreover, while surviving inscriptions on monuments and temples are plentiful, only three hieroglyphic manuscripts are known to have escaped the ruthless destruction at the time of the Spanish conquest. The interpretation of the extant records and the reconstruction of Maya learning are therefore exceedingly difficult. In particular, it has not been possible to determine with certainty the exact dates in the Christian chronology which correspond to dates in the Maya system; and many uncertainties exist as to the interpretation of the astronomical texts.

This monograph is devoted to a discussion of Mayan tables of eclipse dates, tables of heliacal risings, and other similar phenomena of Venus and Mars, and Mayan methods of predicting the dates of equinoxes and solstices, with special reference to the evidence that may be derived from these tables in attempting to correlate the Mayan and Julian calendars.

To follow the treatment, the reader must be familiar with the Maya calendar and the principles of the Mayan astronomical methods. A good introduction to

these is given in the papers by the same author in **Popular Astronomy,** January, 1942, and by Daniel Norman in **The Telescope,** May-June, 1937. Mayan astronomy is characterized by methods of predicting phenomena based on the use of recurrence periods that are integral multiples both of the average period within which the phenomena repeat, and of the fundamental Maya calendrical cycle of 260 days. The eclipse tables, for instance, are based on a cycle of 11,960 = 46 x 260 days, only one day more than 34½ eclipse years. This use of recurrence periods as a means of prediction is very natural; it was likewise practiced by the early Babylonian astronomers who used, among other periods, the well-known 8-year cycle of Venus, also recognized by the Maya.

The author is already known for her previous work on Polynesian astronomy; and the standard of excellence set by that work is maintained in this latest contribution.

EDGAR W. WOOLARD
U. S. Weather Bureau

NEW BOOKS RECEIVED

Navigational Trigonometry, *Paul R. Rider* and *Charles A. Hutchinson,* 1943, *Macmillan.* 232 pages. $2.00.

The mathematics basic to surface and aerial navigation is covered in this text. It includes problems of sailings, projections, and lines of position, and contains trigonometric tables.

Weather Around the World, *Ivan Ray Tannehill,* 1943, *Princeton University Press.* 200 pages. $2.50.

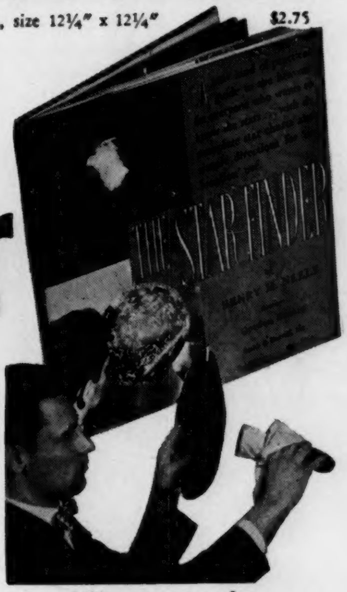
Just what its name implies, a book which tells you what the weather is like in all parts of the world.

The Star Finder, *Henry M. Neely,* 1943, *Smith and Durrell.* 46 pages & charts. $2.75.

A practical and unusual guide to the heavens, with star maps, and diagrams to aid one in learning the principles of star identification for navigation purposes.

A Treasury of Science, edited by *Harlow Shapley,* 1943, *Harper.* 716 pages. $3.95.

A compendium of writings by the scientific masters of the past and present.



LETTER TO THE EDITOR

Sir:

Since being inducted in our Army, I have had just as much use for my elementary knowledge of astronomy as I had in civilian life. Apart from its well-known use for determining quick, accurate directions, astronomy has solved other perplexing problems for this company of G.I.'s There are many who are sincerely interested and we often begin whispered conversations during the 5:30 a.m. roll call. They usually want to know the planets visible — Mars, Jupiter, Saturn, Venus, and Mercury — and often ask about such superstitions as a bright star which follows the moon. Our stolen discussions are usually ended by the first sarge's growl, "You're at ease in there!"

On guard duty a man patrols his post for two hours, is off for four, and goes back on for two. Such a schedule calls for three men and a watch — or else a relief organized and posted every two hours by the corporal of the guard. One evening three of us were driven out to an isolated post in a constructional area. After the truck had returned to tent city, we learned that none of us had a watch. It was a beautifully clear night with a bright gibbous moon and so we just estimated the position of the moon in relation to the horizon after two hours would have passed. We also used the planets as checks during the early morning hours. The system worked perfectly as we had exactly six reliefs through the night, 6:00 p.m. to 6:00 a.m. None of the G.I.'s involved complained — about the time, that is!

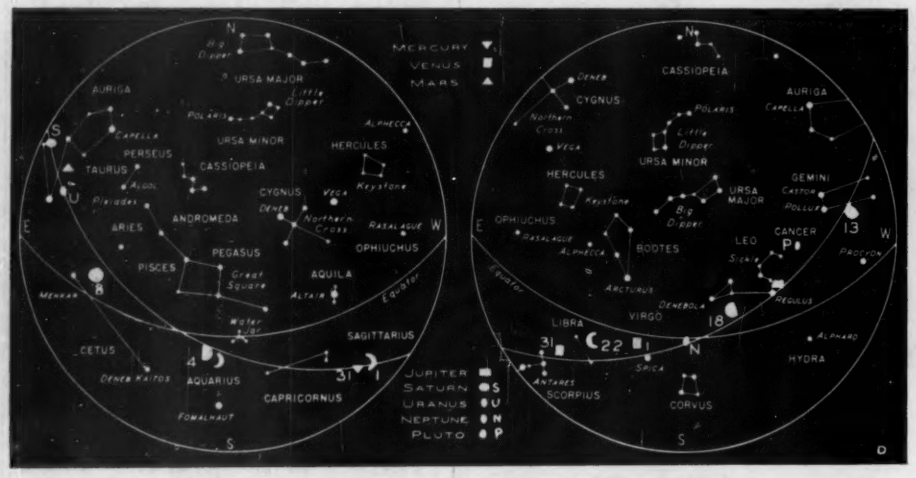
The same situation also arose on day guard duty, but that was just as easy to fix. I remembered the distant tree the moon had set beside the evening before; as the moon was in Pisces, I knew it was near the celestial equator and therefore set near the western point of the horizon. It was only the work of 10 minutes to construct a crude sundial and mark off the reliefs. When the corporal did tell us the time, we discovered we were less than 10 minutes off. However, in this case, luck helped a good deal.

This morning — October 10th, fortunately — the sergeant of the guard wanted to know how long it would be until sunrise and time for chow back in camp. Mercury had just peeped over the eastern horizon and was then about five degrees above it, so I told the sergeant that sunrise would be from 45 minutes to an hour later. Of course, I knew that Mercury was at greatest western elongation, with the sun about 18 degrees behind it. We were back in camp in time for breakfast!

Such are the incidents that pop up, unexpected, but fun to puzzle out. The methods of the ancients are just as reliable now as then, and in our case, just as practical.

PVT. PAUL E. ANDERSON
Camp Ellis, Ill.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 8:30 a.m. on the 7th of the month, and at 7:30 a.m. on the 23rd. At the left is the sky for 6:30 p.m. on the 7th and for 5:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury will be at greatest elongation east, 20° 2′, on December 22nd. Its path in the sky will be almost identical with that of the sun.

Venus, in Virgo and Libra, is still a brilliant morning planet.

Mars. See special article last month.

Jupiter, in Leo, will begin retrograde motion on December 14th.

On December 17th at 1:33 a.m., Jupiter will be in conjunction with the moon and south of the moon's edge by a distance equal to 2/3 of the moon's diameter. At that moment, the P.A. of the moon's axis, 21°, and that of Jupiter's axis, 22°, will cause a line drawn through Jupiter's four satellites to be approximately perpendicular to the line of conjunction. This line, originating at the moon's center, will pass midway between the craters Nicolai and Maurolycus. The four moons will be east of the planet and in numerical order.

Saturn. See special article on the "Observer's Page" in this issue.

Uranus is in Taurus. For an article on the observation of its satellites, see "Astronomical Anecdotes," October, 1943.

Neptune is in Virgo.

CONJUNCTION OF NEPTUNE AND ETA VIRGINIS

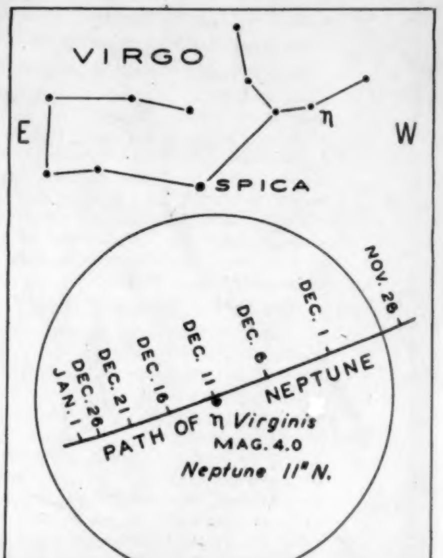
FOR THOSE who have never seen the planet Neptune, an exceptional opportunity to locate it occurs this month as the planet passes the 4th-magnitude star, Eta Virginis. This star lies 21′ 20″ south of the celestial equator and in right ascension $12^h\ 17^m\ 2^s.4$, which places it close to the autumnal equinox.

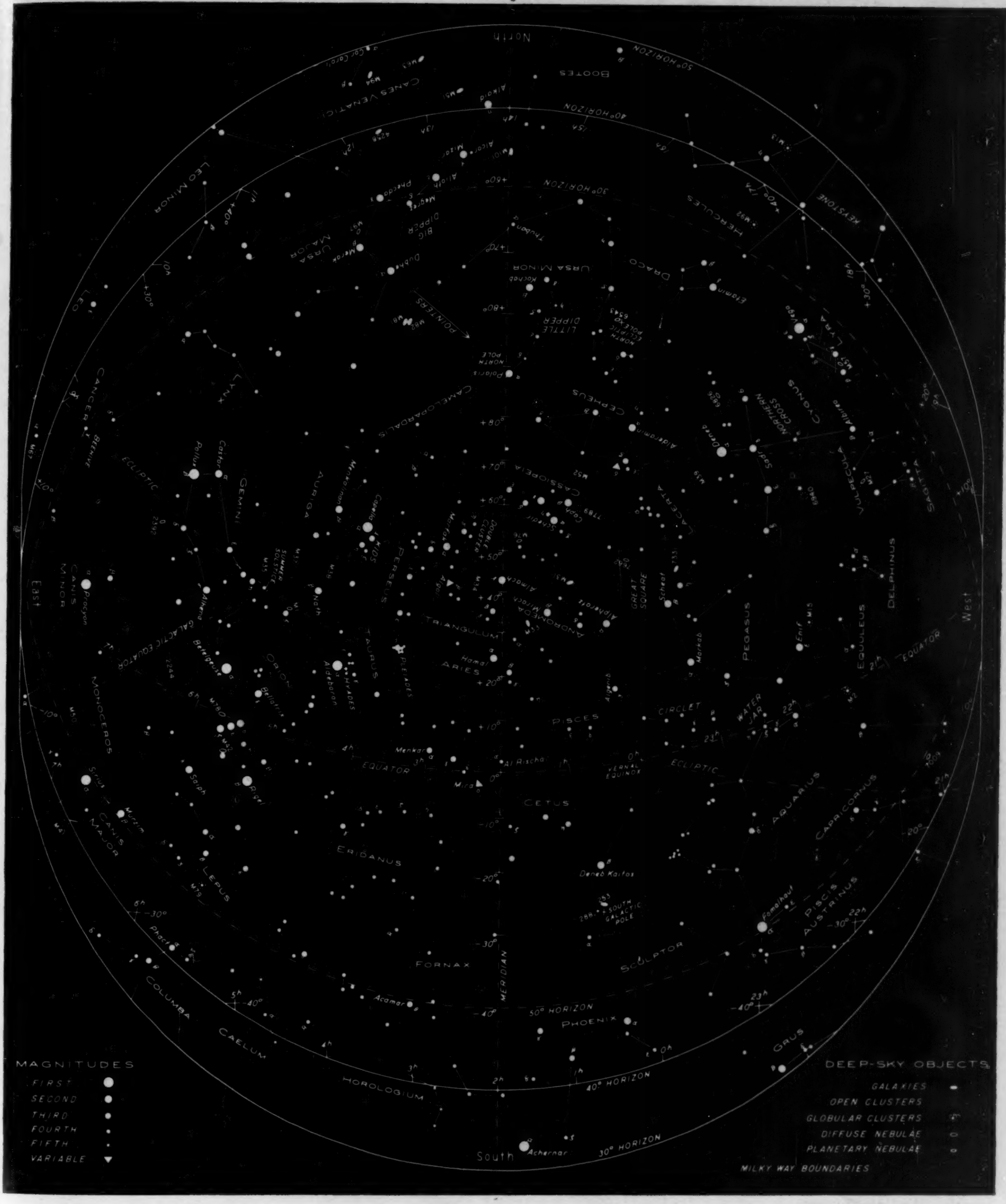
In the diagram shown below, a circle representing the size of the moon is centered on the star, and positions of Neptune are marked along its path at 5-day intervals. In the month, Neptune moves less than the moon's apparent diameter. At approximately 4:00 p.m. E.W.T. on December 10th, the planet and star are in conjunction in right ascension, with Neptune only 11 seconds of arc north of the star. Observations a few days before and after this date should make the motion of Neptune quite apparent, and so establish its identity.

During December, Virgo is well placed in the southeastern sky before sunrise, and, depending on one's longitude and standard time, observations need not be made at too early an hour. It will be necessary, of course, to use field glasses or binoculars, as Neptune is of magnitude 7.7 at its brightest. For the close conjunction, a telescope will be required, as binoculars will not separate star and planet at that time.

Seeing Neptune, particularly if for the first time, is a fine occasion to let the mind go back to September, 1846, when British and German astronomers turned their telescopes to the positions designated by Adams and Leverrier, on the basis of their mathematical calculations, and there discovered Neptune. Something of the same thrill that must have come to those men, nearly a century ago, awaits the observer as he makes his own personal re-discovery of the planet.

H. MALCOLM PRIEST
Pittsburgh, Pa.





DEEP-SKY WONDERS

THIS month finds the following objects in good position for observation with moderate-sized telescopes. Descriptions are from Norton's **Star Atlas.**

Perseus. M76, $1^h\ 38^m.3$, $+51°\ 20'$. A gaseous double nebula, like the Dumbbell in Vulpecula, but much smaller. The Double Cluster, N.G.C. 869 and 884, $2^h\ 17^m.2$, $+56°\ 55'$; $2^h\ 20^m.4$, $+56°\ 53'$. Visible to the naked eye, the two clusters make fine objects in a small telescope. Each is about 45′ in diameter. There is a fine ruby star near the center of 884.

M34, $2^h\ 38^m.8$, $+42°\ 32'$. A fine, loose cluster, just visible to the naked eye. A low power is required to cover the large field.

Taurus. M1, $5^h\ 31^m.5$, $+21°\ 59'$. The Crab nebula, near Zeta, a faint, oval gaseous nebula, thought to be the result of the outburst of a supernova observed by the Chinese in 1054 A. D.

STARS FOR DECEMBER

as seen from latitudes 30° to 50° north, at 10 p.m. and 9 p.m. on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

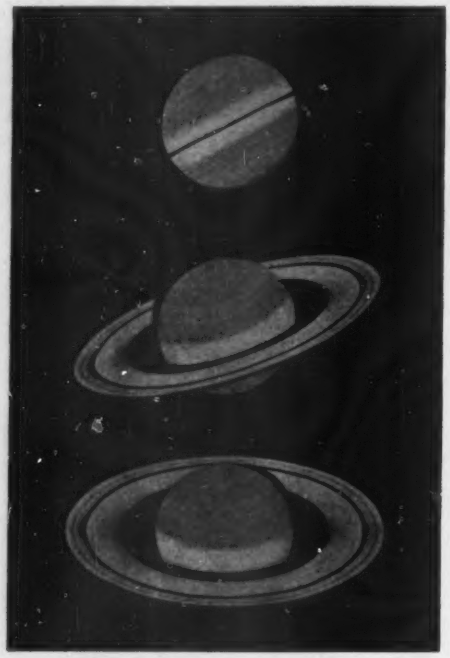
OBSERVER'S PAGE

By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern war time.

Saturn, Its Rings and Its Satellites

The OPPOSITION of Saturn on December 15th will afford an opportunity for both professional and amateur astronomers to study our most beautiful planet under ideal conditions. The three elements, distance, inclination of the rings to our line of sight, and position in the zodiac,



The rings of Saturn: the outer ring A is 10,000 miles wide (including Encke's division); the Cassini division, 3,000 miles; middle ring B, 16,000; Lowell division, 1,000; crape ring C, 11,500; space to planet, 7,500.

will combine on that date to make this the most favorable approach in 30 years.

At the succeeding opposition in late December, 1944, the planet will be nearer the earth by half a million miles, but the opening of the rings will be lessened by about one degree. In both instances, Saturn will be near perihelion, nine degrees short of it this December and five degrees beyond that point a year from now. It is this condition of being near perihelion which makes these oppositions so favorable.

At the oppositions of 15 years ago and 15 years in the future, the opening of the rings also approaches maximum, but the planet was and will be nearly 100 million miles farther from the earth than it is this month. And this increased distance detracts greatly from the planet's brilliance.

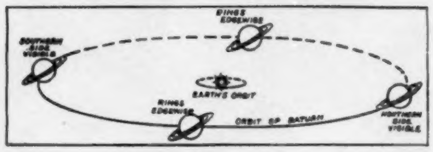
The inclination of Saturn's rings to our line of sight is somewhat analogous to a man wearing a straw hat. If the man's head is erect, we can see only the edge of the hat's brim, but if he tilts his head backward or forward we may view its under side or its top surface, respectively. When Saturn is in Taurus and Gemini, as now, we view the under side or southern surface of the rings — the hat is tilted backward. When Saturn is in Scorpius or Sagittarius, on the "southern" side of the ecliptic, we see the upper or northern surface of the rings.

At the intermediate points, when Saturn is near the autumnal or vernal equinoxes, the rings are tilted neither forward nor backward as we see them, and at a certain moment are so parallel to our line of sight that it is practically impossible to note any sign of them even in large telescopes. This condition occurs when the earth passes through the plane of the rings; it happens on two occasions during each revolution of Saturn. At other times, the plane of the rings does not intersect the earth's orbit.

Just as our equator inclines 23½ degrees to the plane of the earth's orbit around the sun, so Saturn's rings, which lie in the plane of its equator, are inclined 27 degrees to that planet's orbit, and when we observe the maximum opening of the rings, the apparent ellipse of the rings has a minor axis nearly one half of its major axis.

When Saturn is thus seen at the same time that its distance from us is only 748,845,300 miles (at 8:00 p.m., December 15th, based on an astronomical unit of 93 million miles), the amateur's small telescope will reveal many interesting phenomena that can be seen with it at no other time. The rings will have an angular major axis of 46.6 seconds of arc, so that by using a magnification of 100x, their width in the telescope will equal 2½ times the diameter of the moon as it appears to the unaided eye. Surface markings, vaguely similar to those on Jupiter, can be seen with 3-inch or 4-inch refractors or the small sizes of homemade reflectors. The Cassini division, which separates the outer from the middle or bright ring can also be seen in these smaller telescopes as a fine black line. The planet's magnitude at the time of opposition, —0.3, will make it appear brighter than any of the fixed stars in our northern skies except Sirius.

The satellites of Saturn revolve very nearly in the plane of the rings, and the current orientation provides a condition wherein there are no transits of the satellites in front of the planet, nor any occultations or eclipses behind it. At inferior and superior conjunction, the satellites may be seen below and above the planet, respectively, telescopic view.



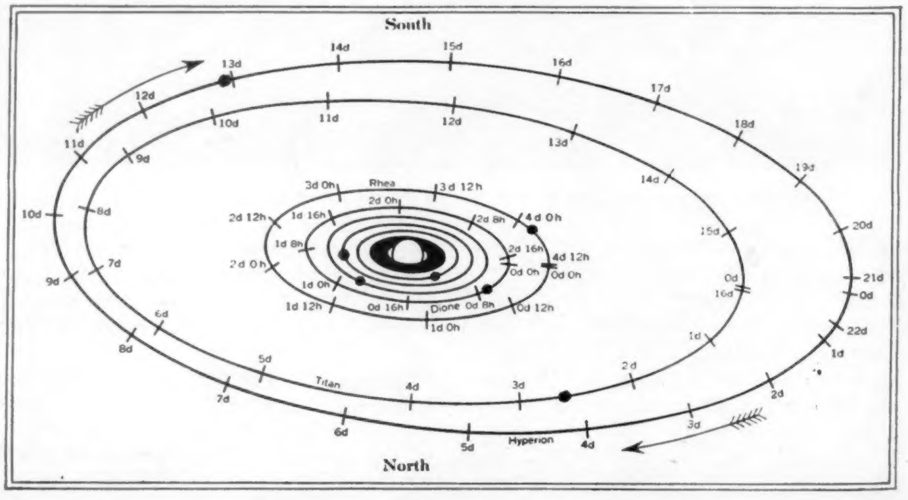
On the diagram shown below, which is taken from the **American Ephemeris and Nautical Almanac,** I have spotted the positions of seven of the nine moons as they may be seen in an inverting telescope at the moment of opposition, December 15th, 8:00 p.m. If seeing should be unfavorable on that evening, positions for other times before or after may be approximated by using the 24-hour motions indicated by short dashes on the outer four orbits or by reference to the table giving the mean synodic periods.

For the benefit of those who might prefer to search for the satellites when at eastern or western elongation, when they are apparently farthest from the primary and so less affected by the glare from planet and rings, the following are the nearest times of eastern elongation: Mimas, Dec. 15, 7:12 p.m.; Enceladus, Dec. 16, 4:06 a.m.; Tethys, Dec. 16, 4:18 a.m.; Dione, Dec. 15, 11:36 p.m.; Rhea, Dec. 17, 11:36 a.m.; Titan, Dec. 14, 4:48 a.m.; Hyperion, Dec. 25, 0:24 a.m.

Finding the satellites provides a real test of the seeing ability of various types of telescopes. Titan, magnitude 8, can be seen easily in a 2-inch refractor, and Rhea,

	Satellite	Mean synodic period	
I	Mimas	0 days	22.6 hours
II	Enceladus	1	8.9
III	Tethys	1	21.3
IV	Dione	2	17.7
V	Rhea	4	12.5
VI	Titan	15	23.3
VII	Hyperion	21	7.6
VIII	Iapetus	79	22.1
IX	Phoebe	523	15.6

With the aid of the diagram below and the table at the right, Saturn's satellites can be located in their orbits at any time.



magnitude 10, is readily found in a 3-inch instrument. Tethys and Dione, each magnitude 11, might be seen with a 3-inch, but seeing conditions would have to be perfect; however, a 4-inch should have no difficulty. Mimas, magnitude 12, is too near the primary to be observed by any but observatory instruments, and Enceladus, also magnitude 12, can be seen by a 4½-inch refractor, but again, seeing must be ideal because the glare from the rings tends to further dim this faint object. It would be better to attempt to locate this satellite with a 6-inch or an 8-inch refractor, or at least an 8-inch reflector; these latter instruments would also be needed to show Hyperion, magnitude 13.

The eighth moon in order from the planet, Iapetus, magnitude 11, can be found easily with a 4-inch refractor, but due to its long period of nearly 80 days, its approximate position must be known. Its mean distance is about three times that of Titan, and it will be at eastern elongation on December 9th, at 1:30 p.m. It will reach inferior conjunction on December 29th, at 10:00 p.m.

THE SUN

On December 22nd at 1:30 p.m., the sun will arrive at R.A. 18^h, Dec. 0°. It will be in the constellation of Sagittarius, which it entered on December 18th.

On December 25th, the equation of time will be 0.0, and the sun will be on each standard meridian at 1:00 p.m. war time. With the sun low in the south, thereby casting long shadows in northern latitudes, this is always a convenient time to establish one's local meridian, making allowance for the difference in longitude between the standard and local meridians.

MINIMA OF ALGOL

December 8, 6:02 a.m.; 11, 2:51 a.m.; 13, 11:40 p.m.; 16, 8:29 p.m.; 31, 4:35 a.m.

THE GEMINIDS

The Geminid meteor shower may be expected to reach maximum on December 12th or 13th.

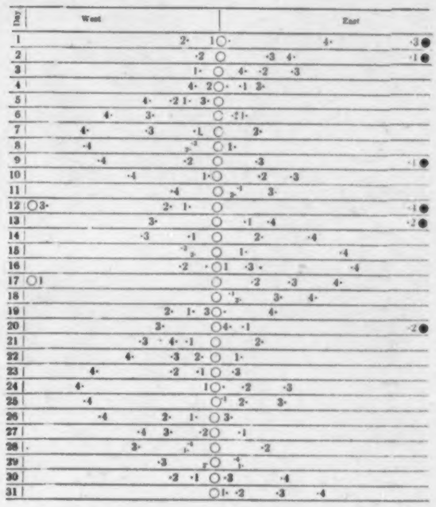
The Geminids are usually short and very fast meteors, of a white color.

JUPITER'S SATELLITES

After 2:16 a.m., December 5th, the four bright moons will be west of the planet.

Prior to 3:28 a.m., the 17th, after 2:53 a.m. on the 18th, and after the conjunction of **I** and **II** at about 3:00 a.m., December 31st, the four moons will be east of the primary and in numerical order, **I** being nearest to Jupiter.

Jupiter's four bright moons have the positions shown below at 4:45 a.m., E.W.T. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the American Ephemeris.



PHASES OF THE MOON

First quarter .. December 4, 7:03 a.m.
Full moon .... December 11, 12:24 p.m.
Last quarter .. December 19, 4:03 p.m.
New moon .... December 26, 11:50 p.m.

OCCULTATIONS — DECEMBER, 1943

Local station, lat. 40° 48'.6, long. 4^h 55^m.8 west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
Dec. 2	7.1	BD —16° 5885	6:24.0 p.m.	41°		
5	6.3	54 B Ceti	10:41.2 p.m.	14°	11:31.2 p.m.	290°
12	4.1	Nu Geminorum	7:47.7 p.m.	21°	8:18.3 p.m.	321°
15	5.6	Theta Cancri	6:47.2 a.m.	115°	8:00.4 a.m.	280°
24	6.4	190 B Librae	5:17.6 a.m.	77°	6:08.5 a.m.	327°
29	6.2	114 B Capricorni	6:41.4 p.m.	63°	7:45.0 p.m.	257°
30	6.2	39 Aquarii	5:17.8 p.m.	109°	6:10.6 p.m.	202°
30	6.1	45 Aquarii	8:56.4 p.m.	75°	9:54.0 p.m.	240°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ THE BUHL PLANETARIUM presents, *beginning December 8th*, THE STAR OF BETHLEHEM.

What was the first Christmas star? Through many centuries men have wondered, and even today no one can be sure. But astronomers, among them the great Kepler, student of the planets and their motions, have named the astronomical possibilities. It is back to the world of ancient Palestine and the lands to the east that December visitors at the Buhl Planetarium travel, to relive the experiences of the shepherds who watched their flocks by night, of the Magi who journeyed to worship their new King. What did these men of so long ago, who held such primitive and simple beliefs concerning the universe, really see? It is this ancient riddle that the modern magic of the planetarium helps to solve, as we recapture the feeling toward things celestial of 2,000 years ago.

★ THE HAYDEN PLANETARIUM presents in *December*, THE WISE MEN'S STAR. (See page 7.)

In *January*, STARS OF A WINTER NIGHT. With the sky playing such an important role in navigating the sea and air, interest has grown in star and constellation study. This month we shall survey the winter sky seen from our own country — and in a short side trip view the stars which shine over our southern neighbors.

★ SCHEDULE BUHL PLANETARIUM

Mondays through Saturdays (except Tuesdays) ....3 and 8:30 p.m.
Sundays and Holidays ....3, 4, and 8:30 p.m.
(Building closed Tuesdays)

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, John F. Landis; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays ....2, 3:30, and 8:30 p.m.
Saturdays ....11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays ....2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Curator*, William H. Barton, Jr.; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles (on leave in Army Air Corps); *Scientific Assistant*, Fred Raiser; *Lecturers*, Charles O. Roth, Jr., Shirley I. Gale, John Saunders.